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GENERAL INDEX TO VOLUME VIII.

THE
BRITISH JOURNAL OF SURGERY

# INTRODUCTION TO VOLUME VIII.

I GLADLY accept the kind invitation to write a prefatory note for the eighth volume of the JOURNAL, because it gives me the opportunity of saying a few words about "The Association of Surgeons of Great Britain and Ireland". Such an Association was very present in the minds of those who started the JOURNAL seven years ago; in fact they had already made up their minds to do their utmost to form one. They worked hard and strenuously, and by 1913 it looked as if their efforts would soon be crowned with success, and as if another year would see the Association firmly established, and adopting the JOURNAL as its megaphone, through which the word spoken in the ear might be, if desired, proclaimed upon the housetops. Five years of war have, however, upset all our calculations as to time; but they have not shaken the firm resolve that British surgeons shall have, not only a journal, but an Association worthy of their country.

During these five years the JOURNAL has appeared regularly in spite of the enormous rise in prices and in wages. It has been well supplied with papers dealing largely, but not exclusively, with the new military surgery, and now that the Association has at last emerged from its larval condition, the JOURNAL starts upon a new phase in its history.

It may be asked what the JOURNAL has to do with the Association anyway; and why it should utter a jubilant note at the Association's birth. The Association, it may be said, meets only once a year, and can only supply a modicum of the matter which will appear in the JOURNAL. I am not sure that this is true. The Fellows of the Association will, it may be hoped, freely bring their new facts—or facts supposed to be new—and their original ideas—or ideas supposed to be original—before the Association, knowing that they will not be at the mercy of reporters, and stimulated by the prospect of free and informal criticism. Then, chastened or elated as the case may be, they will take them back and incubate them. If they hatch out well, but only if they do, the chicks will be exhibited from time to time throughout the year as they mature and get into condition, and the produce of one meeting should not be exhausted before the next comes in sight. Another bond between the JOURNAL and the Association is that the Fellows of the Association will be receiving the JOURNAL throughout the year, and will thus be reminded that they belong to a body which is active and awake, not merely in a state of suspended animation except for a short spell in the month of May. Moreover, they are almost bound to read it. A quarterly periodical is not like a weekly journal which one has hardly time to open before the next number arrives. And our particular journal, if we may be allowed for the moment to boast, will by the excellence of its general get-up and the beauty of its illustrations force the Fellows to see what the articles are about. It is therefore obvious that the interests of the JOURNAL and those of the Association are inextricably combined.

The first meeting of the Association has now taken place, and everyone speaks of it as a delightful occasion, one for making new acquaintanceships and renewing old ones,

a time of instruction and even of inspiration. It is right, however, that we should thoughtfully take stock of it and make up our minds that, if in any ways it came short of our ideals, these particular shortcomings shall not be hardened into precedents for future meetings. I therefore venture, with all humility, to make the following observations.

For my own part I enjoyed the whole of it thoroughly; but when it was all over I was left with the conviction that, if the Association is to lead to real advance, its discussions will have to be more concrete and less didactic. To begin at the beginning: we all listened spell-bound to the fascinating and suggestive oration of the President, and we shall never forget it. It was quite right that the delivery of the inaugural address should be a formal and stately occasion; but if the time of the meetings is to be limited to two days and a half, I think that the opening address will have to be quite short—the concentrated quintessence of the President's wisdom—and that it should be followed by, and perhaps actually lead up to, the first full-dress debate. Then the second meeting might almost be called a brilliant intellectual display, but, in my opinion, the subject was too large for a profitable hour's discussion. I doubt if anyone was converted, or went away with his faith in the perfection of his own methods in the smallest degree shaken. This again was quite right for the first occasion; but another time we might perhaps do worse than take one small part of the vast subject, say, for example, "healing by first intention", which was only mentioned in passing, and see how our debate compares with the striking discussion at the International Medical Congress of 1881, and how far our views of this fundamental subject have matured in the last thirty years. The third meeting was intensely interesting; and it was inevitable, for the opportunity was a unique one. But we must guard against the danger of drawing the surgical intellect of the country together to hear lectures. We must bear in mind that the object of their coming together is for the interchange of thought and the expression of opinion; not merely for seeing one another's faces, but for hearing one another's voices; not so much for listening to discourses *ex cathedra*, as for traversing the statements of the expositors.

I hope it will not be thought ungracious of me to dwell thus upon matters which seem to me to be capable of improvement, rather than upon the undoubted merits of the first meeting. The latter are obvious to all and need no praise from me: the former are less likely to be formulated in thought or set down in words. It is only because the chance of saying what I feel has been unexpectedly put in my way, and because I am so anxious that the Association should be a real living success, and because I think that there is a danger that the 'defects of the qualities' of the first meeting may form the pattern for subsequent ones, that I venture to make these criticisms. And, having been so bold, I will make one more. We met this year in our overgrown and conservative old metropolis, bound by antiquated customs and leaning on ancient traditions. In the future we shall visit the smaller metropolitan cities and go-ahead provincial cities and towns. If we insist upon making our meetings severely business occasions, times of hard thinking and Spartan simplicity, I am confident that all that we hope and expect for the Association will be obtained.

RICKMAN J. GODLEE.

## SIR WILLIAM BLIZARD.

1743–1835.

WILLIAM BLIZARD was born at Barn Elms, near Mortlake, in Surrey, on March 1, 1743, being the youngest but one of the five children of William Blizard, an auctioneer. The family was remarkable for longevity; his father and mother died at the age of 86, his maternal grandmother at 90, whilst he himself attained to 92. After a scanty education at school, Blizard was apprenticed to Mr. Besley, a surgeon and apothecary at Mortlake, and signalized his apprenticeship by making a *hortus siccus* which was long preserved in the family. He was afterwards articled to Mr. Henry Thompson, one of the surgeons to the London Hospital, and he also acted as assistant to a surgeon in Crutched Friars. About this time he attended the lectures of Percivall Pott at St. Bartholomew's Hospital, and of William and John Hunter at the Hunterian school of medicine in Windmill Street. Of Pott he said in 1815: "By the lot of human nature few men can now record his talents as a lecturer; and in vain would be the attempt to describe the elegance of his language, the animation of his manner, the perceptive force of his truths and doctrines".

Blizard was admitted a member of the Corporation of Surgeons on February 6, 1772, and was soon afterwards appointed surgeon to the Magdalen Hospital, a post he resigned when he was elected Surgeon to the London Hospital on September 21, 1780, upon the death of his former master, Henry Thompson. He then became associated with Dr. Maclaurin, a Scotch physician, well known as a teacher of anatomy. Lectures were given at first in a small house in Thames Street and afterwards in Mark Lane. Blizard taught the surgery, which he was well able to undertake, as he performed all the operations at the London Hospital, his two colleagues Mr. Grindall and Mr. Neale leaving this part of the hospital duty entirely in his care. In 1785 he founded the first regular medical school in connection with a large London hospital. The Committee of the London Hospital gave the ground, whilst Blizard made himself responsible for the buildings which were erected at a cost of several thousand pounds. The school was opened on October 27, 1785, and the event was celebrated by an ode composed by Blizard, set to music by Dr. Samuel Arnold, and performed at the London Tavern, which was then one of the fashionable assembly-rooms for philanthropic meetings. He was invited to occupy the Chair of Chemistry at Guy's Hospital in succession to Dr. William Saunders, who had become physician to the hospital; but he remained faithful in his allegiance to the London, and undertook the lectures on anatomy, physiology, and "chirurgical pathology and practice" The lectures were largely attended, and attracted John Abernethy, who acted as his prosector. Abernethy always held Blizard in the highest esteem, and says of him: "He displayed to us the beau ideal of the medical character. I cannot readily tell you how splendid and brilliant he made it appear, and then he cautioned us never to tarnish its lustre by anything that wore even the semblance of dishonour".

Blizard loved the London Hospital with his whole heart, and devoted the main energies of his life to its welfare. He induced most of his wealthy patients to become governors, and in 1791 he was instrumental in establishing the Samaritan Fund, now known as the 'Marie Celeste', for the relief of poor patients when they left the hospital. In a public appeal for the fund he pointed out that "the greatest exertions of art and the most diligent care are extended to poor, sick, and hurt fellow creatures. But skill and tenderness will hardly avail against disease whilst the mind is continually depressed by reflection upon a hopeless prospect in life or upon the condition of a family pining with grief and want". Such sentiments carried into practice reflect the highest credit on Blizard's humanity, and the more so when it is remembered how great was the gulf which in his time

separated the rich from the poor, and how small was the consideration paid to the feelings of the poor by the majority of his contemporaries.

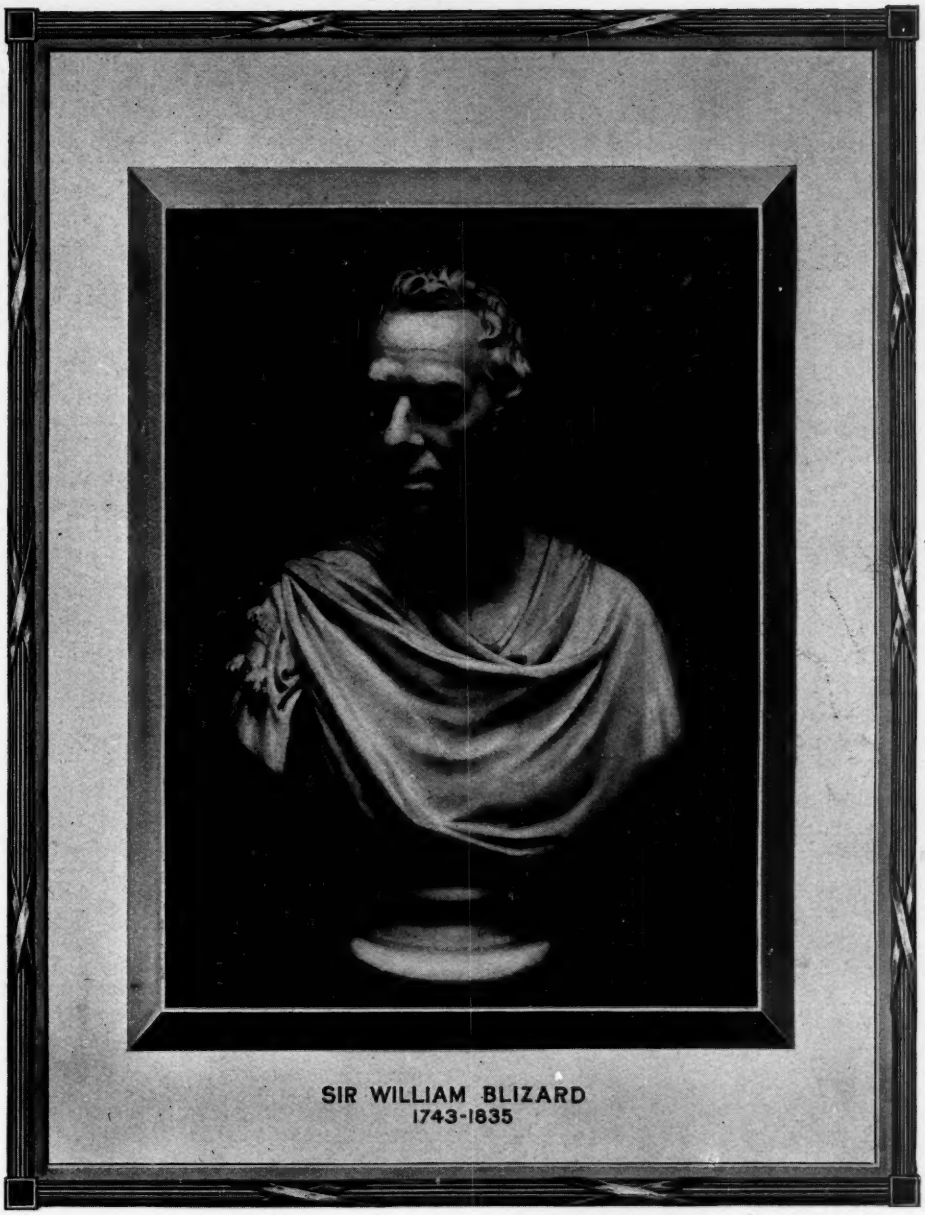
Blizard was public-spirited as well as philanthropic. From 1781 to 1790 he was surgeon to the Honourable Artillery Company; on resigning this office he was elected a member of the Court of Assistants, and in 1794 he became one of the trustees of the Company's estates. He was also an active member of the London Military Foot Association, which was formed for the purpose of supporting the civil power in the maintenance of peace and order. In this capacity he rendered valuable help during the Gordon riots in 1780, and Heath's engraving of the Broad Street disturbance shows Blizard in the foreground in the act of picking up a wounded insurgent, whilst another rioter is aiming a blow at him with a club and is restrained by a third, who seems to recognize him. Later in life he received a commission as lieutenant-colonel in the 6th Regiment of London Loyal Volunteers.

Blizard was elected Professor of Anatomy in the Corporation of Surgeons on July 5, 1787, and a Fellow of the Royal Society in the same year. His services as professor were duly appreciated, and on July 3, 1788, he "was unanimously re-elected, the usual gold medal being awarded to him". He was chosen a member of the Court of Assistants of the Corporation on January 7, 1796, and on the dissolution of the Company he was nominated a member of the Committee appointed to draft the charter for the present College of Surgeons which rose on its ashes. At his suggestion, his friend and pupil Samuel Jackson founded the prize in 1800 which is still known as the Jacksonian prize, and has led to the production of much sound surgical work and to the enrichment of the Museum. Blizard became a member of the Court of Assistants of the College of Surgeons in 1800, and continued to attend the meetings until his death in 1835. He became Master of the College in 1814, and filled the same office, with the title of President, in 1822; in 1812, 1813, and 1820 he was Governor of the College, and he delivered the Hunterian Oration in 1815, 1823, and 1828. It is evident that he had inherited considerable business capacity, for in 1811 "the grateful thanks of the College were presented to him for the extraordinary services he has rendered as one of the auditors, whereby the old and very complicated accounts have been settled and arranged, and a short and very clear mode of keeping them in future has been established". This resolution was proposed by his fellow auditors on the ground that they were the immediate witnesses of the services he had rendered. In 1803 Sir William received the honour of knighthood from King George III, on the occasion of his carrying an address from the College of Surgeons.

As might be expected, Blizard's energies were not confined to surgery. He became a Fellow of the Society of Antiquaries in 1779. He was one of the founders of the Anatomical Society, whose object it was to legalize the supply of subjects for dissection. He was amongst the early members of the London Institution. He was one of the first members of the Horticultural Society, over which he presided at the annual meeting when he was in his 93rd year. He was instrumental in establishing the Hunterian Society, and after serving as its first President in 1819 he was invited to continue for a second term of office.

In 1821 he left London and went to live at Brixton Hill, and in the same year the Governors of the London Hospital decided that "as it is most desirable to secure the connection of Sir William Blizard with the hospital during the remainder of his valuable life, and to provide for the discharge of his duties there with comfort to himself when the period shall arrive at which he may consider it necessary in some degree to relax his exertions: it was resolved that it be recommended to the General Court to appoint a surgeon as special assistant to Sir William Blizard, which appointment is to cease upon the demise or resignation of Sir William Blizard". He continued in office, however, until 1834, when he suffered from double cataract, and the lens of the right eye was successfully removed by Sir William Lawrence. He died of senile decay on August 28, 1835, having taken part in the College examinations seven days previously. He is buried in a vault in Brixton Church.

Sir William was tall in person, and his features were strongly marked. He was prone to jocularity, and would indulge himself in merriment on the prominence of his nose and



SIR WILLIAM BLIZARD
1743-1835

the development of the muscles which denote the passions. It is recorded that one day, walking round the Museum of the College of Surgeons, he stopped before the busts of Sir Everard Home and himself. Pointing to them, he said, " There, sir, look at that pudding-faced bust: every interstice is filled with fat, there is not a particle of expression; but look at the other and you see it all character and expression ". The portrait painted by John Opie, R.A., and presented by Samuel Jackson, which hangs in the Council Room at the Royal College of Surgeons in Lincoln's Inn Fields, has taken away much of the character and expression upon which Sir William Blizard prided himself. Chantrey's bust appears to give a more lively presentment of his features. The reproduction illustrating this article is taken from it, by the kind permission of the Governors of the London Hospital. There is also in the possession of the Hospital a smaller bust by C. A. Rivers, which was executed about 1834.

Habits and customs changed during Blizard's long life. He was perhaps the last hospital surgeon in London who attended regularly at a coffee house—Batson's, in Cornhill—that the apothecaries, i.e., the general practitioners, might consult him. He always went armed, and one night on leaving the Court of Examiners he missed his hanger. This made him furiously angry, and he ordered it to be found forthwith, " For with it I am in fear of no one, not even the devil himself ". Guthrie, one of his colleagues, added slyly, " In that case he had better have it put into his coffin ". Notwithstanding his weapon he was stopped one night when driving along Essex Road, and relieved of his watch and purse, for his pistol missed fire. Afterwards, recollecting that the watch had been given to him by a friend, he asked to have it returned. " There, my honest fellow ", said one of the thieves, " take your watch ". The man had been under Sir William at the Hospital, and had recognized him.

Sir Norman Moore, in his recently published *History of St. Bartholomew's Hospital*, gives the following version of a well-known story about Blizard. He says: " Sir Richard Owen was engaged upon some anatomical investigations on the human eye which made him wish to dissect one very soon after death. He obtained leave, therefore, to be present when the bodies of two men who had been hanged were delivered to the President of the Royal College of Surgeons in accordance with the ancient grant.

" The College hired a house in Cock Lane—just behind St. Sepulchre's Church in Giltspur Street—to which these bodies were brought from the place of execution outside Newgate. Owen was in a room on the first floor with Sir William Blizard, the President, who was attired in court dress as the proper costume for an official act. They heard the shouts of a crowd, and then the noise of an approaching cart, which turned down Cock Lane and stopped at the door. Then came the heavy steps of the executioner tramping up the stairs. He had the body of a man who had been hanged on his back, and entering the room let it fall on a table which was placed for the purpose, and then brought the other. Sir William Blizard with a scalpel made a small cut over the breast bone, and bowed to the executioner. This was, I suppose, the formal recognition of the purpose for which the body had been delivered. The rumbling of the cart, the contrast between the stiff figure of Sir William Blizard in his court dress and the executioner in coarse clothes, and the thud of each dead body on the table, remained in Owen's memory to the end of his days."

Blizard's memory was remarkably retentive, for he not only remembered the details of anatomy for many years after he had ceased to teach the subject, but he was able to recite entire passages from Shakespeare, and within a year of his death, when dining at a friend's house, he repeated aloud to the company the whole of Gray's *Elegy in a Country Churchyard* almost without hesitation, although he said that he had not read it for forty or fifty years.

# SCIENCE AND SURGERY.

THE INAUGURAL ADDRESS AT THE MEETING OF THE ASSOCIATION OF SURGEONS OF GREAT BRITAIN AND IRELAND, MAY 13, 1920.

BY THE PRESIDENT, SIR JOHN BLAND-SUTTON.

SURGERY is probably an ancient occupation like that of the gardener, cobbler, or potter. The gardener required few tools—a knife, axe, spade, and basket: also bast and fibre. The potter required fewer, and the astonishing results he produced with his fingers on a lump of soft clay, with the aid of a wheel, made a deep impression on the minds of thoughtful men. The potter's productions resembled creative acts, and this idea is emblazoned in the Jewish and Christian conceptions of the creation of man—God made man in His own image. Gods fashioned by the potter, *Dii fictiles*, were regarded with reverence by the Romans.

When the potter acquired the art of firing and glazing his clay productions, he made them imperishable.

Surgeons work on very perishable material and for their own time, for manual dexterity appeals only to witnesses.

Surgery is allied to cobblery. The tools of the surgeon and the cobbler are of three kinds: cutlery—knives and shears; implements for aiding manipulation—pincers and a last; and means for joining parts—threads, bristles, awls, or needles. Replace the last by a saw, and the tool-bag for each is complete. Denoted by their modern names—scalpel, scissors, saw, forceps, needles, sutures and ligatures—such a set of tools is sufficient for seventy-five per cent of the operations performed by surgeons.

*Good craftsmen produce excellent results with simple tools.* Modern surgical instruments are excellent in shape and quality, but at the time of the destruction of Pompeii, 79 B.C., tools used by surgeons were as gross as those of farriers and tinkers. The Pompeian mural painting preserved at Naples shows Iapyx attempting to remove the head of the dart from the thigh of Æneas. The wounded hero, supported by his faithful friends, Mnestheus and Achates, leans on his long spear; Ascanius, his son, weeps as the surgeon, with coarse forceps, tugs vainly at the dart. Venus, with her face muffled in a thin cloud, pitying but triumphant, supplies the tincture that releases the missile, heals the wound, and enables Æneas to fight again (*Fig.* 1).

Surgery should interest all. Everybody who survives birth is subject to a simple operation, omphalotomy, tying the navel cord. This simple act requires a piece of string and something with which to divide the cord. In the absence of knife, shears, a potsherd, or a piece of sharp flint, it may be bitten through, as in the case of animals. Surgery had its beginnings in such simple operations as omphalotomy, circumcision, and the sewing-up of wounds, and it remained a simple craft for centuries. The prime duty of the surgeon was the treatment of wounds and injuries: this involved the use of threads and needles, and implements for the reduction of dislocations.

## OMPHALITIS.

Prehistoric midwives probably used the same kind of ligature-material that surgeons use to-day: fibre from plants, especially flax; tendon, catgut—in use for musical instruments—could scarcely escape employment as string; and silk. Though midwives tied the cord with string, surgeons did not appreciate its value for tying a cut artery until the sixteenth century, and it was in the latter part of the nineteenth that they learned the

dangers attending the use of dirty threads for such purposes. In my early days surgeons waxed the threads, like cobblers, with the hope of avoiding sepsis. The use of thread for tying the umbilical cord has had a dreadful post-operative mortality from general sepsis, the umbilical vein serving as the channel of infection. The literature relating to

FIG. 1.—Æneas wounded. The surgeon Iapyx extracting the head of the dart from the wound in the thigh of the hero. *Æneid*, xii. (*Mural painting from Pompeii, Naples Museum.*)

omphalitis is extensive; Miller's account of the appalling infant-mortality from this cause in the Moscow Foundling Hospitals, published in 1888, and the well-known "scourge of St. Kilda", are examples of the deadly nature of this kind of wound infection.

Omphalitis has attracted much attention during the last thirty years, and now

strict surgical measures prevail in the birth-room, a new literature has sprung up relating to it, and as many methods are advocated for amputating the placenta as for removing a pile.

Endeavours to ascertain the cause of sepsis exercised the minds of the greatest surgeons. Seventy years ago the riddle seemed as insoluble as the cause of cancer appears to-day. Although the preparation of alcoholic beverages and bread by fermentation has been practised from remote periods, and festering wounds were as familiar as fermentation, and the rotting of dead plants and animals even more familiar, it was left to Pasteur and Lister to prove that these apparently dissimilar processes—fermentation, suppuration, and decay—are due to minute living organisms.

## PARTICULATE CAUSES OF DISEASE.

The microscope enabled men to discover particulate causes of disease and to discern the manner in which they are distributed in the body. When we watch with a microscope the circulation of the blood in the web of a frog's foot, the passage of the red corpuscles through the capillaries is as exciting as our first glimpse with a telescope of Jupiter's moons or the belt of Saturn. Who, fifty years ago, on seeing the corpuscles whirling in the blood-stream, could imagine that in a few decades improvement in technique would enable pathologists to write of the flora and fauna of the blood with the same familiarity as that with which botanists and zoologists discuss the plants and animals special to a continent?

The distribution of minute parasites in the blood is instructive; some sport in the liquor sanguinis, some select the white corpuscles, and some the red. Grosser parasites use the blood-stream for transport to favourite sites for multiplication, and some permeate the walls of the arteries. Extreme minuteness to the microscopist is like enormous distances for the astronomer. One talks confidently in micro-millimetres, and the other in millions of miles. Who shall contradict them with equal confidence?

The Royal College of Physicians celebrates yearly the discovery of the circulation of the blood. The discovery of the lymphatic system was almost as important. Asellius found the lacteals by accident in 1622. He opened a living dog to investigate the action of the diaphragm, saw the lacteals filled with chyle, and recognized their nature. His enthusiasm would have led him to open living men as he had dogs, but he checked this inclination (Cruikshank). Now surgeons daily open living men and interfere with the stomach; in the course of such operations they can often show to the students lacteals turgid and white with chyle (especially if the patient has swallowed some milk two hours before operation: it is a common demonstration), and thus repeat the original observation of Asellius.

Cruikshank states that Harvey never believed in the existence of lacteals. We owe much to the zealous anatomists of the Windmill Street school, who investigated the lymphatics; now their origin, course, and termination in man's body are as plainly depicted in text-books as roads are delineated on motor-maps.

*Lymphatics are the subtile channels by which infective material reaches the circulation for distribution—and mischief.*

## THE GLANDULAR PANTHEON.

One of the oldest occupations is that of shepherd, and the stockyard might not inaptly be called the cradle of physiology. For centuries shepherds have known that complete removal of the genital glands renders animals useless for reproduction, but makes them docile and fat.

Few suspected that other glandular organs were associated with growth and reproduction until it was discovered that complete removal of the thyroid gland induced myxœdema. Gradually the long-suspected relationship of the thyroid to cretinism was established. As with all knowledge that depends on observation, progress was slow:

"Precept must be upon precept, precept upon precept; line upon line, line upon line; here a little, and there a little". This surely applies to the slow accumulation of our knowledge concerning the potency of thyroid secretion. Its influence on growth has recently been studied experimentally on the metamorphosis of batrachians. Frog-tadpoles change into frogs precociously if fed on mammalian thyroid. A more striking effect occurs in the axolotl (*Fig.* 2), the tadpole stage of the tiger salamander, but it differs from the frog-tadpole by reproducing its kind whilst in the larval stage. When the axolotl was first brought to Europe, Cuvier shrewdly suspected it to be a larva. Many years later a captive axolotl lost its gills and frills, acquired movable eyelids, quitted the water, and became a terrestrial salamander (*Fig.* 3). Axolotls in this country occasionally transform, and J. E. Huxley has induced precocious transformation by feeding them on ox-thyroid. In his experiments the metamorphosis took place

FIG. 2.—Axolotl.

FIG. 3.—Tiger salamander.

in three weeks, as against seven to forty weeks (Madame Chauvin) and six to twelve weeks (E. G. Boulenger) under normal conditions.

Two structures in the body of vertebrate animals have always had for me a peculiar fascination—the notochord and the pituitary body; each is as constant as the backbone. The discovery of the influence of the pituitary secretion on the growth of bones opened the eyes of physiologists, and they slowly realized that the growth and development of animal bodies are governed by a glandular pantheon, and of the divinities in this curious pantheon the pituitary body presides over the growth of the skeleton.

It must strike even a casual observer as strange that two contrasted men such as Patrick Cotter, the Bristol giant, and the fat man, Daniel Lambert, weighing 739 lb., whose portrait adorned many tavern signs, were products of disordered glandular action (*Fig.* 4).

The discovery that Hunter's giant, Charles Byrne, alias O'Brien, had an enlarged pituitary body, is one of the romances of the museum. After Marie discovered the relationship of the pituitary body to acromegaly, surgeons became interested in studying its effects on the skeleton. Prof. D. J. Cunningham, during a visit to the museum, slipped his finger through the foramen magnum of the unopened skull of the giant, and found the pituitary fossa shallow and expanded : its walls had undoubtedly been levelled

FIG. 4.—Patrick Cotter, the Bristol giant, 8 ft. 7 in., and Daniel Lambert.
(*Kirby's Wonderful Museum*, 1804, vol. ii.)

by an enlarged hypophysis. Keith subsequently cut a movable lid in the cranial vault and made the eroded fossa available for easy inspection. Patrick Cotter was a contemporary of Hunter's giant in London. He had big hands, and a cast of one is preserved in the College Museum. Cotter was caricatured by Rowlandson in 1785, two years after Hunter's giant was dead and skeletonized. Grego, Rowlandson's biographer, describes the caricature as being drawn with skill and originality ; it represents the giant as

graceful though gigantic. In the picture, the giant's right hand is resting on the head of a military commander. The ladies are struck with wonder at such gigantic limbs, and one is comparing her tiny foot with the large and well-proportioned member of the giant (*Fig.* 5). The sketch contains other whimsicalities, and hangs in the conservator's office.

The most striking feature of giants, apart from their height, is the enormous size of their hands. This is shown in the drawing and in Rowlandson's caricature. These drawings were made nearly a century before acromegaly was detected or suspected.

Goliath of Gath, whose height was six cubits and a span (9 ft. 9 in.), had big hands, for the staff of his spear was like a weaver's beam.

FIG. 5.—The astonishing Irish Giant, 1785. (*Rowlandson.*)

I saw the hand of an acromegalic musician that could span 16 inches. This man played the double bass, and his wide span gave him excellent control over the strings.

It is strange that overgrowth of the most cunningly concealed glandular body in man is responsible for making its owner the most conspicuous person in an assembly. In spite of the apparent inaccessibility of the hypophysis in its neat little cave in the base of the skull, the radiologist can ascertain its dimensions during life with the same certainty with which he detects stones in the kidney.

**Avian Clubs.**—Some remarkable effects of glandular activity on the character and dress of birds may be studied in sparrows. In winter these birds, cocks and hens, live in flocks, and their twittering in the trees at sunset is a familiar feature in the dull

season. These societies may be called avian clubs, and they are sociable meetings, for in winter the testicles of the cocks are about the size of the pips of pippins (*Fig.* 6). In March, as the days lengthen and there is more sunshine, the testicles enlarge, and in May they are as big as sparrows' eggs. Apart from the special reproductive functions associated with the testicular increase, there are two features of importance: the colour of the feathers is more vivid, and the bird becomes pugnacious and combative. The sparrow is such a common bird that most of us take as little notice of it as of the Litany, but the nut-brown plumage of the cock sparrow in April is exquisite, when with trailing half-spread wings he deploys before the coy hen, and is so absorbed in the pursuit as to forget the presence of man.

Jackson's whydah bird presents a good example of resplendent nuptial plumage. This bird is closely allied to the sparrow, and in the quiet season it is difficult to distinguish by plumage the cock from the hen. On the approach of the pairing season the cock undergoes an extraordinary change. All the feathers except the primaries and secondaries become black (*Figs.* 7, 8). The tail feathers lengthen and assume a sickle shape.

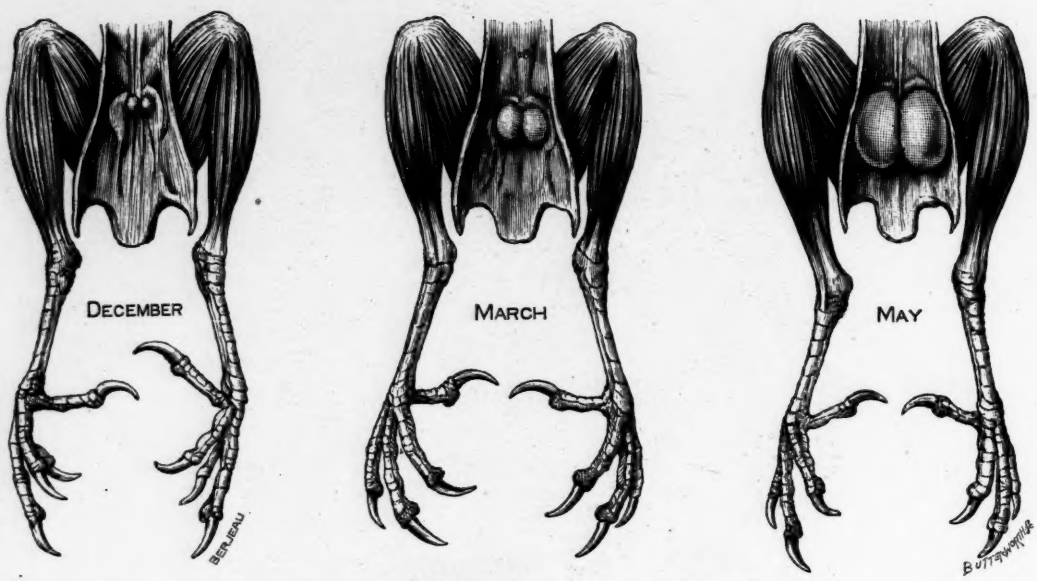



FIG. 6.—Seasonal changes in the sparrow's testicles.

In flight, the tail spreads out like a parachute, and the bird seems to float rather than fly. During courtship the cock indulges in extraordinary antics, in which wings and tail play a conspicuous part. At the end of the breeding season the cock moults, and cocks and hens live in communities, consisting of thousands, among the reeds.

It is remarkable that this finch in a few days produces a large amount of feathers, large in comparison with its bulk, and as black as ink. The source of the pigment is unknown. I often think that if its source were known, much of our ignorance in regard to melanoma would be dissipated.

It is a simple question to ask, Why does the cock have such fine plumage for the ceremonies of courtship, whilst the hen is covered with sombre feathers? It is more puzzling to explain why a hen, when she grows old and ceases to lay eggs, occasionally becomes cock-feathered.

In 1917 the College of Surgeons acquired the drawing of a duck (*Fig.* 9) feathered like a drake, even to the curly feathers on the tail. Under the drawing, in John Hunter's handwriting, is the statement that the bird made a noise sometimes like a duck and sometimes like a drake. The sexual difference in the voice of the duck and the drake

is well known, and is associated with a modification of the syrinx. In the drake there is an osseous bulb (*Fig.* 10) or labyrinth connected with the trachea and syrinx. The quack of the duck is loud and sonorous; of the drake, inward, harsh, and feeble. On a dark night, when these birds assemble by hundreds in marshes and shallow estuaries, they quack apparently for the sake of keeping company (Gilbert White). It is easy to distinguish the voice of the duck from that of the drake. It would be useful to ascertain if drake-feathered ducks also acquire a labyrinth to their syrinx.

FIG. 7.—Jackson's whydah birds, cock and hen.

**Testicles and Feathers.**—The relationship of testicles and feathers has practical importance for the ostrich farmer. Stanley Elley, a veterinary surgeon, practised the caponizing of ostriches in South Africa to check the breeding of inferior birds. The operation also enhances the value of feathers, tames vicious birds, and produces good parents. Sir Arnold Theiler informed me that during the war caponization practically ceased because of the slump in ostrich feathers, and the number of birds has enormously decreased.

In a bachelor ostrich the testicles weigh about an ounce, but in an old cock a pair weigh about 2 lb. The operation is not difficult, the risks are small, and the bird seems immune to peritonitis. In the hen the ovary is removed with good results. In cocks

the effects of castration on the feathers is due to the subsequent docility of this combative bird. Fighting spoils feathers. In the hen the value of the feathers is enhanced because the bird becomes cock-feathered and the feathers tend to become black.

A critic may ask, What have testicles to do with feather production when a hen without any trace of ovarian or testicular tissue becomes cock-feathered? The evidence suggests that the endocrine glands are closely correlated in sex manifestations. Morgagni is credited with the observation that there is relationship between the development of the cerebral cortex and the cortex of the adrenal, but it is a modern discovery that

FIG. 8.—Jackson's whydah bird dancing in its playing-ground.

the adrenals are associated with the activity of the sexual organs. Mott regards the adrenal cortex as a storage of lipoid: in the fœtus it builds up the myelin of the developing nervous system, but in adults, as occasion arises, this lipoid can pass into the blood and keep constant the supply for the reproductive organs, where it serves as raw material for formative nuclear activity, an action essential for the production of spermatozoa.

The hormone secreted by the genital glands must be very potent, for the engrossment of the sexual act is such that amplectant frogs are often transfixed by inquisitive boys with sharp sticks, and Phinehas, Aaron's zealous grandson, treated a man of Israel and a

Midianitish woman in the same fashion with a javelin (Num. xxv. 7). Shackleton has collected photographic evidence that love is as ardent among birds and beasts

FIG. 9.—Duck in drake plumage.

during the cold summer of the Antarctic as in the heat of the Torrid Zone.

The enterprising spirit of South African veterinary surgeons is matched by their colleagues in Canada and the United States, where they make skunks as respectable as castrated cats, and much more profitable. Young skunks are obtained in May, as soon as their eyes are open, for then they are easily weaned and will eat bread and milk. The anal glands—scent-sacs they are euphemistically called in America—can be easily, safely, and almost painlessly excised in the young skunk. This operation—called 'disarming the skunk'—requires for its performance a scalpel, forceps, clamping forceps, hook, probe, and a pair of goggles. The clamping-forceps prevent the escape of the stinking fluid, and the use of goggles saves the operator's eyes in case of such an accident.

A disarmed skunk makes a good pet, and may be carried about like a kitten: it eats dead fowls, mice, fruit, vegetables, grubs, and beetles.

Skunk fur is admired by women, and the fur can be improved by cross-breeding.

Among other advantages claimed for a disarmed animal, is this: a tame skunk placed in the window of a store for advertising purposes will draw a big crowd.

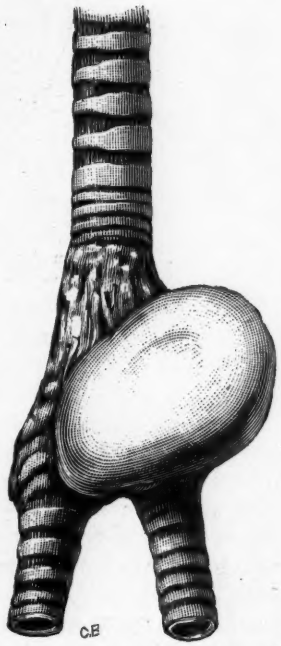


FIG. 10.—The syrinx of a drake (*Anas boscas*).

## EMBRYOLOGY.

Next to speculations on the beginning of the world, nothing absorbs attention more than the origin of life, and the production of animals out of themselves always excites wonder and curiosity. The relationship of embryology to surgery has always had for me an irresistible attraction. I vainly imagined that embryology would help to solve the problem of the origin and growth of tumours, and a large part of my leisure for many years was devoted to this question. Of all tumours, dermoids attracted me, especially those which arise in the ovary. In relation to these singular tumours, which fifty years ago were regarded as curiosities, much has been learned, and the chief light on their origin has come from experimental embryology.

Patient section-cutting, and observation in the laboratory, proved that the tissues of the embryonic rudiment in an ovarian dermoid contained imperfectly developed tissues, and organs of an embryo—skin, hair, glands, teeth, cartilage, bone, trachea, thyroid gland,

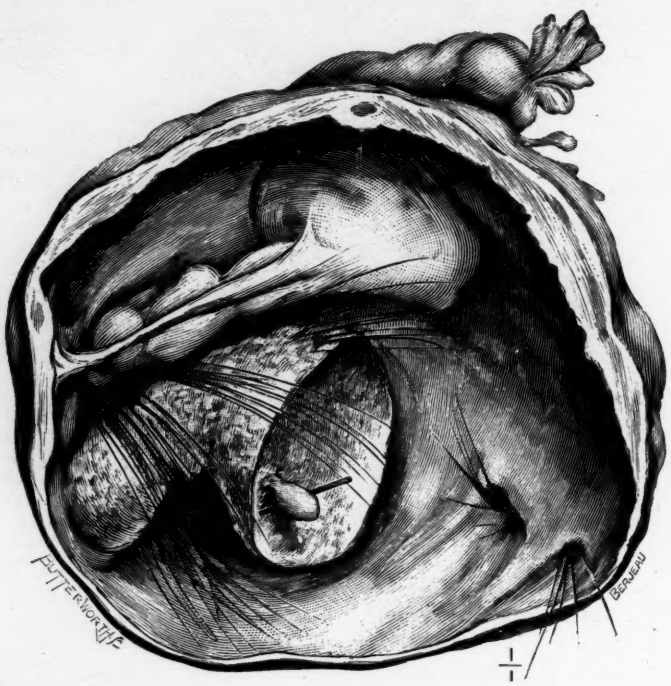


FIG. 11.—Ovarian dermoid. The small oval structure in the embryonic rudiment is invested with stout fibrous tissue, and contains nerve cells and medullated fibres. (*St. Thomas's Hospital Museum.*)

brain, eye, spinal cord, and (rarely) intestine, but so far no reproductive glands. In an embryonic rudiment in an ovarian dermoid removed from a woman, age 30, Shattock isolated a small oval structure invested with a capsule of stout fibrous tissue which, as told microscopically, contains nerve cells and some medullated fibres (*Fig.* 11). It gradually dawned on pathologists that these conglomerations of fœtal tissues could only be produced by the activity of an ovum; but observational embryology led men to believe that an ovum could only be stimulated by a spermatozoon of its own species. Since the discovery that mechanical stimulation is sufficient to start segmentation in an ovum, it has become a commonplace experiment in biological laboratories to irritate frogs' eggs with delicate stylets and produce what are now known as 'fatherless frogs'. These successful experiments indicate that ovarian dermoids might not inaptly be called 'fatherless embryos'.

These experiments can only be carried out on large eggs like those of the frog and its

kind. The method is not available for the production of race-horses, nor for heirs to ancient titles or great estates, when the sire is impotent : nor is there any reason to believe that it will relieve human beings of what St. Paul politely styles evil concupiscence (Colos. iii).

### LAMPS AND SPECIALISM.

Before the invention of the incandescent lamp, the chief specialities rested on instruments that reflected sunlight, lamplight, or gaslight. By such simple means advances were effected in laryngology, ophthalmology, and gynæcology. The incandescent lamp enabled ingenious instruments to be constructed for illuminating internal cavities. To this class belong the cystoscope, bronchoscope, and sigmoidoscope. Each instrument requires skill in employment and experience in interpreting things seen. This accounts for much dismemberment in clinical surgery.

Radiology has transformed the methods of diagnosis in respect of intrathoracic disease. Good skiagrams of the chest will reveal calcified lymph-nodes, tumours of the mediastinum, and aneurysms of the big vessels. With the help of an opaque meal an intrathoracic stomach has been identified, and an œsophageal diverticulum can be localized and its size and suitability for removal duly estimated.

In the case of a foreign body in the chest, the utility of the $x$ rays has long been demonstrated, and the detection of a sovereign or a bicycle—a toy bicycle—in the gullet excites curiosity, but it is a dramatic spectacle to watch a shrapnel ball in a cardiac ventricle, rapidly moving in its orbit, and recalling, in its activity, Phobos, the little satellite of Mars.

The chest is now an established field for surgical enterprise. There are indications that $x$-ray lamps and screens will be as available in wards and consulting-rooms as incandescent lamps are to-day.

The art of surgery is now so wide that no man can expect to be expert in all branches. Specialization is a necessity of modern surgery ; the Association will help to concentrate the results and keep surgeons abreast of the progress made in the great hospitals of the kingdom. Apart from the regular discussions, personal conversations will be even more useful, and promote good fellowship among surgeons.

Before all things let us remember that fellow-craftsmen should not be competitors, but comrades of the same honoured craft or guild.

# DUODENAL DIVERTICULA.

By EDMUND I. SPRIGGS.

With Radiographs by O. A. MARXER.

In the last thousand consecutive *x*-ray examinations of the alimentary tract made at Duff House with an opaque meal, diverticula of the duodenum have been noted ten times. Although such diverticula are uncommon, the shadows they cast on the screen or plate may cause confusion unless their nature be recognized; and they may in rare instances give rise to symptoms.

Morgagni is said to have been the first to describe a typical pouch of the duodenum, and the statement is copied from author to author throughout the literature. A perusal of his account, however, leaves me in doubt. He refers in two letters commonly cited, and in at least three others, to excrescence, pedicle, prominence, or lacerated flap about the ring of the pylorus; but the description suggests other forms of pedunculated tumour; and in a case he mentions more than once, it appears from the context that the tumour lay inside the lumen, for he remarks that it might have obstructed the pyloric opening, An earlier case, that of Chomel, also often referred to, is probably of a different nature, as the cavity contained numerous stones. A pouch of the small intestine is mentioned, with several references, in a note by the translator, Soemmering, of Matthew Baillie's *Morbid Anatomy* in 1794, though it is not clear whether Meckel's diverticulum is included. In this country Habershon (1857) referred to duodenal diverticula. Perry and Shaw in 1893 gave a detailed account of non-inflammatory pouches, based on fourteen examples. Buschi, of Bologna, in 1911, collected fifty-four cases of which exact accounts were available, including three of his own. He referred to sixty-two previous authors, including Rolleston and Fenton (1901), and Keith (1903). Two years later Wilkie wrote a good summary, with fresh cases and excellent illustrations of post-mortem specimens. In 1917, Ritchie and McWhorter had found seventy-six cases in the literature, and published a radiogram of a case under their care. They mentioned that eleven others had been reported by radiologists, some of which had been corroborated at operation.

Duodenal pouches may be caused by ulceration or other pathological processes involving the wall of the bowel, and possibly by extrusion of weak parts of the wall without gross disease. In favour of extrusion from internal pressure as a cause of non-inflammatory pouches, Perry and Shaw point out that the duodenum is the only part of the small intestine in which ulcers produce pouches. They suggest that closure of the pylorus when the duodenum is contracting will cause a higher pressure than is likely to be produced elsewhere in the small intestine. Keith also urged that a region in which pouches are often found, namely, near the papilla of Vater, is a weak point in the musculature.

Others believe that the majority of the pouches are congenital, because they have many times been found when there was no evidence of inflammation, dilatation, or hypertrophy of the bowel near by; and chiefly on the inner concave aspect of the horseshoe-shaped duodenum, which is supported to some extent by the pancreas, and would, according to these writers, presumably be less liable to pressure extrusions than the convex aspect. Extrusion from internal pressure may reasonably be excluded in such a diverticulum as that mentioned by Grey Turner, in which the mucous membrane at the apex of the pouch was thrown into folds. The congenital origin of many such diverticula is also

supported by the considerations that they are frequently single; that the development of the pancreas and liver in the embryo as outgrowths from the duodenum make the occurrence of other outgrowths not improbable; that many duodenal diverticula have their distal pole lying close to or in the pancreas, and some are associated with accessory pancreatic tissue. Lastly, duodenal diverticula are sometimes found with other congenital anomalies such as congenital folds of the duodenum (Wilkie), Meckel's diverticulum, and diverticula of the œsophagus; also with stenosis of the duodenum (E. Shaw). But generally it may be noted that in congenital stenosis of the small intestine, although the bowel above the obstruction is commonly dilated, pouching of this type is not usually recorded (N. I. Spriggs).

The fact that nearly all duodenal diverticula have been found post mortem in elderly people is an argument of weight in favour of the view that they are acquired and not congenital. But it must not be forgotten that most post-mortem examinations are of elderly people. Also congenital diverticula, which were at first small, may become larger and more obvious from dilatation as the years pass.

It appears likely, from recent post-mortem statistics, that duodenal pouches will be found oftener than hitherto if a careful search be made. They are easily overlooked at autopsy, and still more so on the operating table, as the aspect of the duodenum from which they arise is usually extraperitoneal.

The commonest situation is the second part of the duodenum. More than one diverticulum may be present, but, unlike the small colic diverticula, they are most frequently single, and to find more than two is rare.* Buschi mentions the site of forty-four cases. Adding to these the cases of Bauer, Wilkie, Basch, Ritchie and McWhorter, and Berblinger, we find, out of 57 cases, 11 in the first part, 2 in both first and second parts, 41 in the second part, and 3 only in the third.

The size varies from a linseed to a hen's egg (Buschi), and is usually about that of a walnut (Perry and Shaw). The mouth of the diverticulum is frequently wide, admitting a finger-tip or even the thumb. The structure is that of the duodenal mucous membrane, with the muscularis mucosæ, and frequently some fibres—often atrophic—from the outer muscular layers.

As a rule, duodenal diverticula are harmless, no doubt because they drain easily from the wide openings. The fact that their existence has generally been revealed accidentally after death bears witness to their innocent nature. Wilkie thought that, in two out of his three cases, stagnation in a diverticulum may have led to chronic duodenal catarrh. One case died of acute hæmorrhagic pancreatitis; gall-stones were present. The other had duodenal ulcer, cholecystitis, gall-stones, and advanced cirrhosis of the liver. In that patient alcoholism, which presumably caused the cirrhosis, was also a likely cause for duodenal catarrh; and in neither case was definite inflammation of the lining membrane of the sac, or clear evidence that a sac pressed on surrounding parts, noted. But in at least two published cases it seems clear that a non-inflammatory diverticulum gave rise to disease. In one (Bauer) a large diverticulum of the second part of the duodenum was thought, when filled, to have pulled on the pylorus and caused persistent vomiting. The patient became cachectic; gastrojejunostomy was done, but he continued to vomit, and died eleven days later. Bauer published another case, which has been quoted by others, in which he attributed pathological consequences to a diverticulum; but the original description is not convincing, as the patient, who was 80 years of age, died of hæmorrhage from a 'struma' in the chest.

The second case in which the evidence seems clear that a diverticulum caused symptoms is that of Basch. The patient complained of flatulence, 'sour stomach', and aching of the right upper quadrant of the abdomen, which came on an hour after food. A diagnosis

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* Multiple small acquired diverticula of the duodenum, jejunum, and ileum were found by Hansemann in a man of 85, in whom the multiple diverticula sometimes found in the large intestine in elderly people were also present.

was made, before *x*-ray examination, of chronic inflammatory disease in the duodenal region of the gall-bladder. A pouch was detected by *x* rays at the junction of the second and third parts of the duodenum. At operation the second part of the duodenum was dilated and hypertrophied, apparently from the efforts of the gut to force out the contents of the sac. The diverticulum was excised and gastrojejunostomy done. Basch suggests that some patients in whom a duodenal ulcer is expected but not found at operation, may have a duodenal diverticulum, which may easily be missed by the surgeon.

A brief description of the cases which came under our notice is now given.

## DIVERTICULA OF THE SECOND PART OF THE DUODENUM.

*Case* 1.—No. 642. **Early Graves' disease.**

Male, age 55. (*Fig.* 12.) Barium was seen in a diverticulum of the second part of the duodenum.

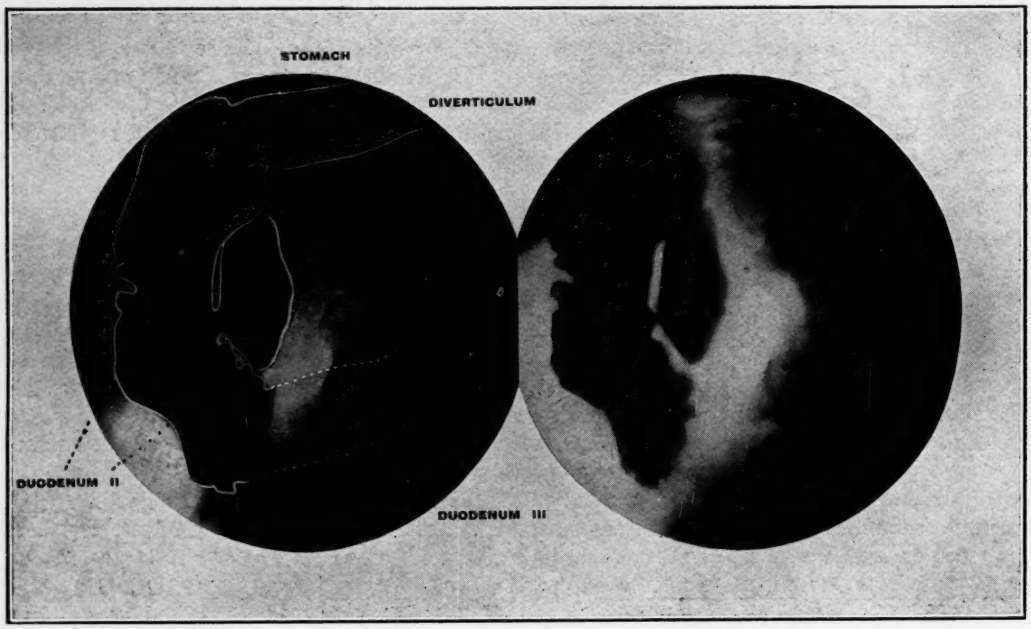


FIG. 12.—Early Graves' disease.

*Case* 2.—No. 880. **Nervous exhaustion and sleeplessness.**

Male, age 69. (*Fig.* 13.) Two gall-stones were removed twelve years before admission. A typical mushroom-shaped diverticulum was observed on the inner side of the second part of the duodenum, communicating by a wide mouth with the lumen.

*Case* 3.—No. 612. **Gastric and duodenal ulcer.**

Male, age 51. Gastro-enterostomy ten years ago. Recent hæmorrhage. Deformities of the pyloric part of the stomach and the first part of the duodenum were visible. The barium also entered a small rounded cavity on the inner side of the second part of the duodenum.

*Case* 4.—No. 529. **Hæmorrhoids and constipation.**

Female, age 72. (*Fig.* 14.) A small diverticulum in the second part of the duodenum. The duodenum above appeared to be held upwards and forwards by adhesions, and showed exaggerated activity at the early stages.

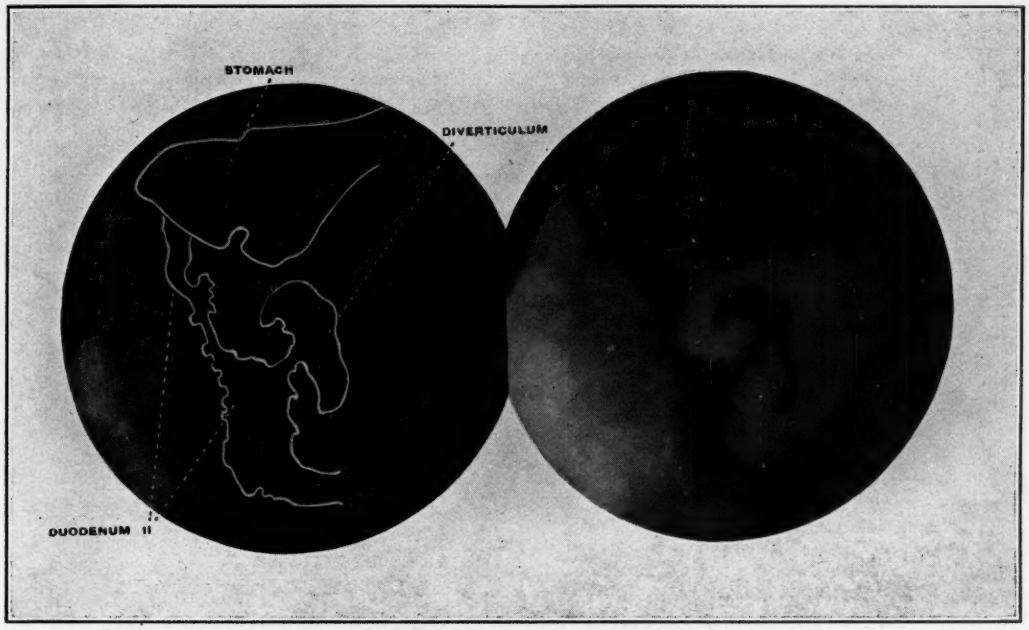


FIG. 13.—Nervous exhaustion and sleeplessness.

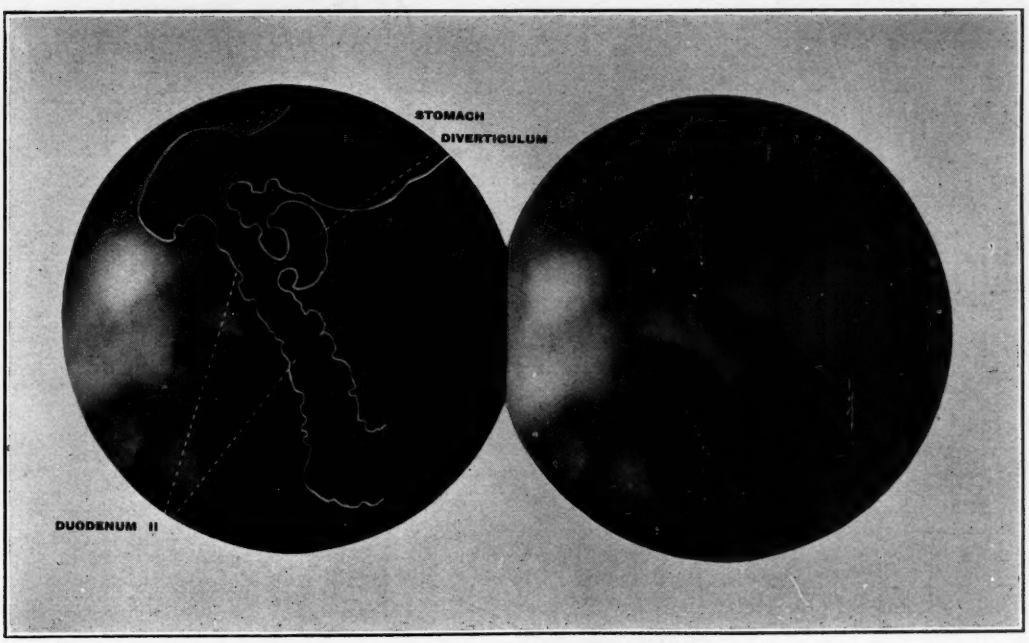


FIG. 14.—Hæmorrhoids and constipation.

*Case* 5.—No. 1424. **Hypochlorhydria (Achylia).**

Male, age 54. (*Fig.* 15.) Two diverticula, one large and one small, were seen on the inner side of the second part of the duodenum. They retained barium some hours after the stomach and duodenum were empty.

The patient complained of nausea, with occasional vomiting, and attacks of diarrhœa. He had brought up some blood three times in twenty-three years. The achylia was of a sufficiently severe degree to explain his present symptoms, and with treatment for that complaint they have now been relieved.

In this case the diverticula cannot be absolved from a share in causing symptoms. The patient is still under observation. Exploration will be advised if his progress is interrupted by recurrence of nausea or vomiting.

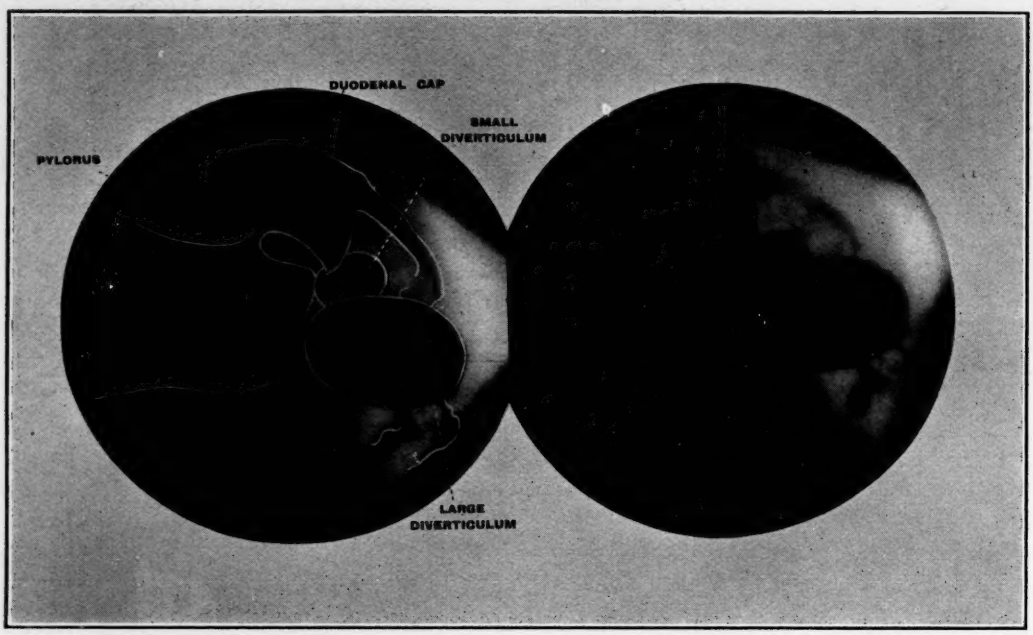


FIG. 15.—Hypochlorhydria (achylia).

*Cases* 1, 2, 3, and 5 were typical diverticula. In *Cases* 3 and 4 we connected the shadow at the time with the lesions of neighbouring parts of the duodenum, not being then aware that the neighbourhood of the ampulla of Vater is a favourite seat of these pouches. Cases are found in the literature in which diverticula of the non-inflammatory type and duodenal ulcers or gall-stones occur together; but a causal relation has not usually been established.

## DIVERTICULA OF THE THIRD PART OF THE DUODENUM.

*Case* 6.—No. 696. **Irritable colon following repeated dysentery.**

Male, age 41. (*Fig.* 16.) The abdomen had been opened and the appendix removed. The patient says the surgeon told him there was no obstruction at the duodenojejunal flexure. *X* rays showed a large pouch in the third part of the duodenum projecting up into or in close connection with the pancreas. It had a definite neck, and was empty at seven hours after the opaque meal, two hours later than the stomach.

*Case* 7.—No. 996. **Large cystic right kidney.**

Female, age 53. (*Fig.* 17.) The duodenum was much displaced by the tumour. Its third part showed a large diverticulum with an indentation of its upper outline. The observation was verified at operation.

FIG. 16.—Irritable colon following repeated dysentery.

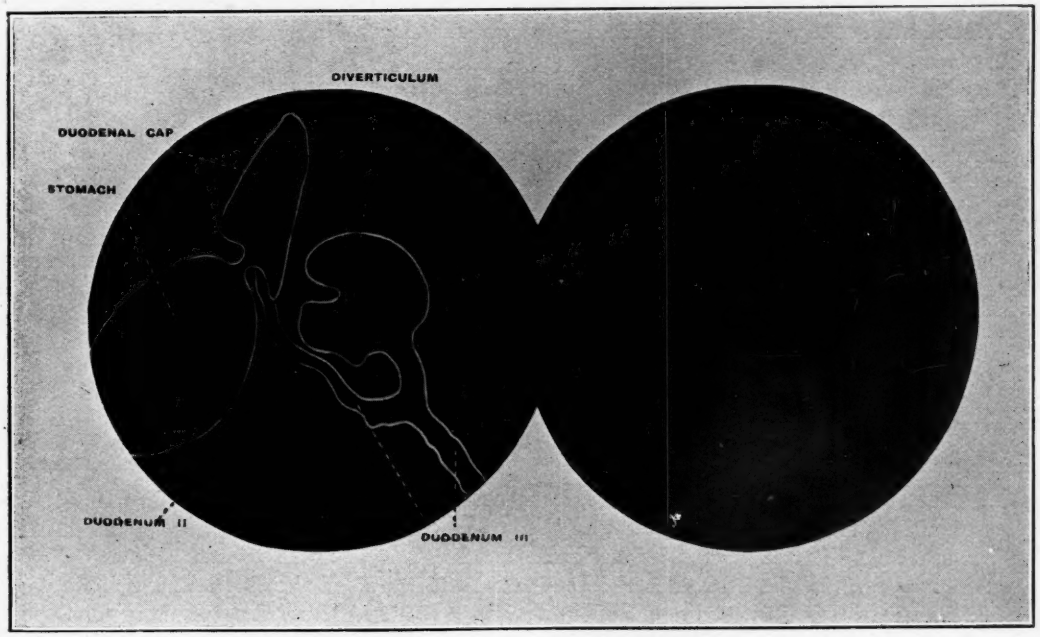


FIG. 17.—Large cystic right kidney

*Case* 8.—No. 1325. **Nervous exhaustion following overwork during the war.**

Male, age 53. (*Fig.* 18.) A large pouch was seen in the neighbourhood of the head of the pancreas. A channel could be followed between the pouch and the third part of the duodenum.

*Case* 9.—No. 795. **Chronic appendicitis (operation) and mitral regurgitation.**

Male, age 53. (*Fig.* 19.) A large single diverticulum was seen with *x* rays near the duodenojejunal flexure (in the modern nomenclature this would be reckoned as in the fourth part of the duodenum). It was not observed by the surgeon when he examined the duodenal region at operation. This patient was also the subject of a small diverticulum of the ileum, and small multiple diverticula of the colon. His case was one of those reported at the discussion on diverticulitis at the Royal Society of Medicine on Jan. 7 of this year.

*Case* 10.—No. 1245. **Gall-stone. Intestinal stasis. Hæmorrhoids.**

Female, age 44. A small single pouch was seen projecting from the upper border of the third part of the duodenum, in the region of the head of the pancreas.

Of these cases, five were in the second and five in the third part of the duodenum. Diverticula of the third or horizontal part of the duodenum are rare in the literature, only three cases being recorded by the authors referred to above.

Three of the patients with a pouch in the third part had had the abdomen opened, and in two of them the pouch had not been detected. In *Case* 6 the surgeon had specially examined the duodenojejunal flexure, close to the diverticulum, and had not seen it, probably because the pouch and its neck would lie entirely behind the peritoneum.

In nine of the ten cases the symptoms did not appear to be connected with the diverticulum, the diagnoses being Graves' disease, neurasthenia (2 cases), gastric and duodenal ulcer, hæmorrhoids, and constipation (2 cases, 1 also with a gall-stone), post-dysenteric colitis, cystic kidney, and chronic appendicitis.

In one patient (*Case* 5) it appears likely that the two diverticula present may be associated with the symptoms complained of. He is still under observation, and is improving with treatment for his hypochlorhydria.

*Case* 6, the subject of a huge cystic kidney, died after operation. The other patients recovered from their complaints and are well. Four of them are following active occupations.

In three other patients barium was noted to enter the ampulla of Vater, which was dilated and showed depressions, ascribed to biliary calculi, in the otherwise smoothly-outlined shadow in the ampullæ. These cases are of a different nature and are not included. In one of them the diagnosis has been verified by operation.

The shadows cast by opaque material in pouches may be puzzling when first observed. In *Case* 9 the shadow of the apex of the pouch projected behind and above the outline of the lesser border of the stomach in the erect position, simulating the appearance of the crater of an ulcer. If the pouch is filled, but not its neck, it is necessary to watch on the screen until a moment at which contents pass down the duodenum, in order to establish the relation of the bowel to the shadow.

## SUMMARY.

1. Ten cases of single diverticulum of the duodenum, discovered in the course of over a thousand *x*-ray examinations of the alimentary tract, are reported, with radiographs.

2. Five were in the second and five in the third part of the duodenum.

3. One case was observed at operation. In two of the others the duodenum had been examined by a surgeon, but the diverticulum had not been detected.

4. The shadows of duodenal diverticula may cause confusion at the *x*-ray examination.

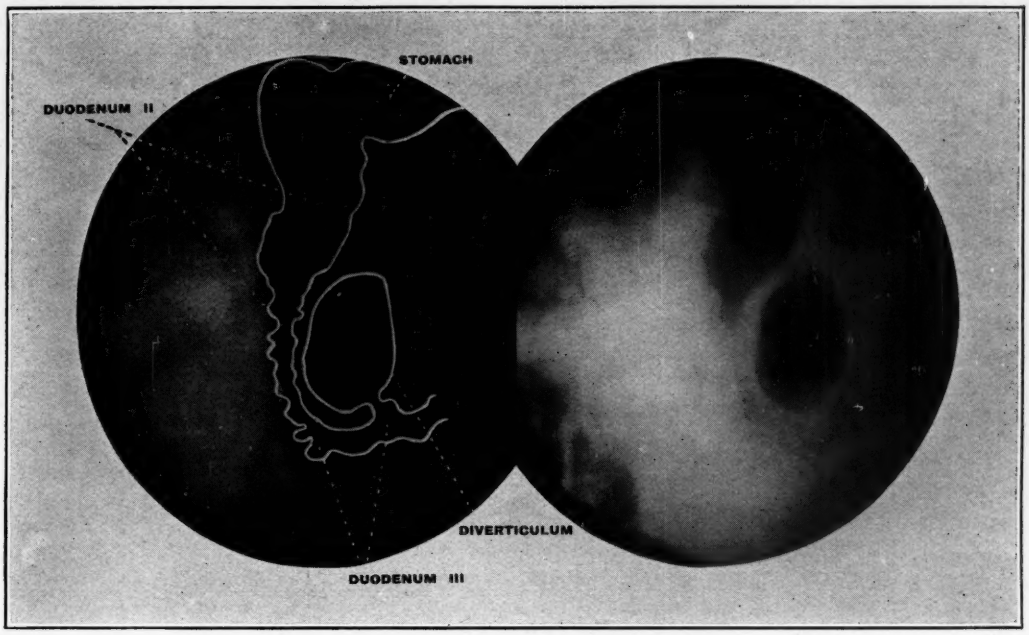


FIG. 18.—Nervous exhaustion following overwork during the war.

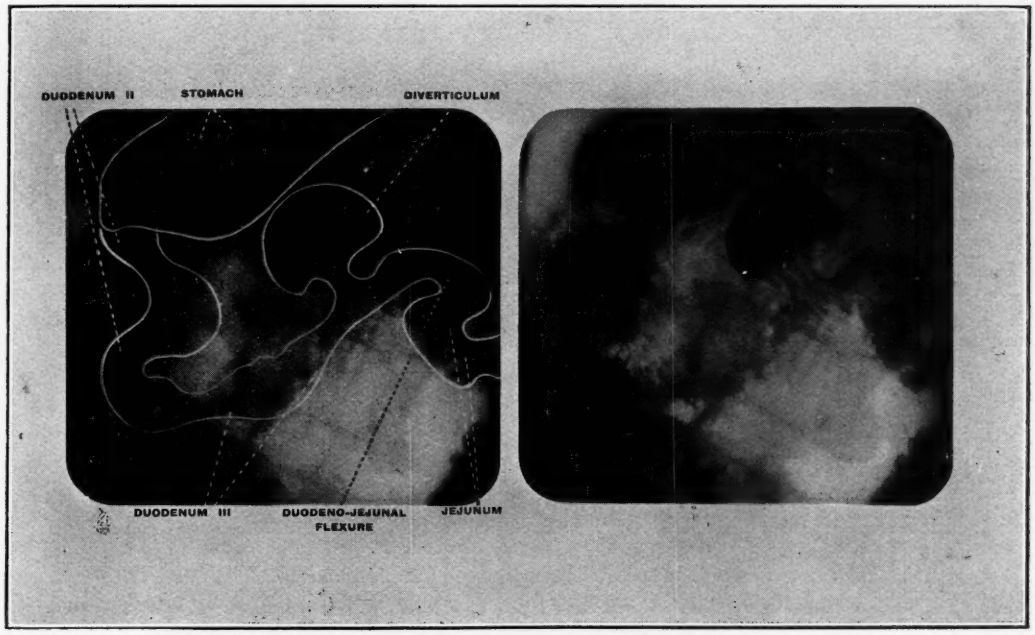


FIG. 19.—Chronic appendicitis and mitral regurgitation.

**5. In nine of these cases the symptoms were not connected with the diverticula. In one case, still under observation, the point is doubtful. The literature shows that such diverticula have, though but rarely, been the cause of disease.**

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# THE RITUAL OF A SURGICAL OPERATION.*

By Sir BERKELEY G. A. MOYNIHAN.

Every operation in surgery is an experiment in bacteriology. The success of the experiment in respect of the salvation of the patient, the quality of healing in the wound, the amount of local or constitutional reaction, the discomforts during the days following operation, and the nature and severity of any possible sequels, depend not only on the skill but also upon the care exercised by the surgeon in the ritual of the operation. The 'ritualist' must not be a man unduly concerned with fixed forms and ceremonies, with carrying out the rigidly prescribed ordinances of the surgical sect to which he owes allegiance; but a man who, while observing with unfaltering loyalty those practices which experience and experiment have together imposed upon him, refuses to be merely a mimic bound by custom and routine. He must set endeavour in continual motion, and seek always and earnestly for simpler methods and a better way. In the craft of surgery the master word is simplicity.

The ritual of an operation commences before, sometimes long before, the incision is made, and may continue for a long period after the wound is healed. In the transition of a patient from ill health to sound health the operation itself is only one—though it may be the most important—of all the factors concerned in this fortunate event.

In this discussion we are not asked to deal with two essential preliminary propositions, the necessity for the most careful clinical inquiry into all aspects of the patient's history and condition, so that accuracy of diagnosis may be achieved before operation; and the exact relevance of the proposed operation in the particular conditions recognized by this inquiry, or discovered during the course of the operation itself. A great many mistakes are still made in both these matters. It is useless, to say the least, to perform the most perfect technical operation in conditions which do not call for it; and the test of a successful operation is not restricted to the healing of the wound, but to the ultimate effects of the procedure upon the disorder of the patient.

When conducting our experiment in bacteriology, we must recognize that micro-organisms capable of causing the direst disaster may possibly be everywhere—in the air, on the hands, instruments, gauze, catgut, etc., which may be introduced into the wound, or upon the surface of the patient's body. The possibility of the patient's own tissues furnishing a septic organism is so remote that we may leave it out of account entirely. It is an excuse to condone rather than a reason to explain the occurrence of infection.

Our bacteriological experiment may be conducted with one of two intentions: (1) The exclusion of all organisms from the wound; (2) The destruction of all organisms reaching the wound, by a bactericide applied to the wound surfaces.

It is not accurate to speak of these two methods as those of 'aseptic' and 'antiseptic' surgery; for to speak strictly there is no 'aseptic' surgery. In every operation some antiseptic is used on the surgeon's hands or the patient's skin. The terms are accurate enough if they are held to apply only to that part of the operation which begins with the incision of the skin. After this point the use of antiseptics in a 'clean' case is rarely necessary, is often undesirable, and is almost always of greater harm than benefit. It is to insult tissues and to doubt them, when it would be better to trust their very considerable powers of self-defence.

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* Remarks made at the opening of a discussion at the first meeting of the British Association of Surgeons, held at the Royal College of Surgeons, May 14, 1920.

In speaking of the results of an operation a surgeon may be a prejudiced witness as to his own efforts, and a bad judge of his own merit. When we speak, for example, of 'healing by first intention', what do we mean? What is our standard? Let us take extreme examples. In the one we mean a wound which heals within a few days, leaving a thin, straight, narrow line of palest pink. Around this line and the stitch-marks everything appears 'cold'. There is no redness, no swelling, no stiffness or induration, and at the line itself the most accurate apposition of skin edges is seen. There is no discharge from the wound. There has been neither local nor constitutional reaction following the operation. In the other, we mean a wound which is anything but straight; the edges are jagged, they do not meet accurately at every part, they overlap here and there; the line of healing is broad and irregular, raised and red, a sticky discharge oozes from the unapposed surfaces, and a scab may lie where this discharge has dried. The parts around are raised, tender, doughy, or stiff. The stitches seem to sink into the skin. You may see wounds of this kind in some clinics, and hear a complacent comment that the wound has healed by 'first intention'. Such wounds are the clearest evidences either of a bad technique or of a clumsy operator, or perhaps of both. If we had a Dr. Johnson in our profession, and he were asked his opinion of such wounds, what would he thunder in reply? We know what he said when pressed for his opinion of a young lady's verses. "Why, they are very well for a young miss's verses; that is to say, compared with excellence, nothing; but very well for the person who wrote them".

In every discussion it is necessary for the protagonists to agree as to definitions and the exact meaning to be attached to words; otherwise polemics are valueless. We must here discriminate between 'perfect' and 'imperfect' healing, though both may be classed as examples of healing by 'first intention'. It is, moreover, not only a question of the healing of the superficial, visible wound which is our concern. With the two types of wound healing I have described there are associated, not only the varying chances of life or death, but also two types of convalescence, especially in abdominal cases. In the former the patient suffers hardly at all, indeed, as a rule, not at all, unless there have been great technical difficulties in the operation itself, such as remoteness of the parts concerned in a very stout subject.

For example may be quoted an operation for cholelithiasis, in a very fat woman, when the liver lies high, and the gall-bladder is small, bound up in dense adhesions, fixed to the duodenum (perhaps with a fistula into it) and the back of the abdomen. The liver and costal margin may need to be held up, and the abdominal viscera to be dragged downwards, before the sclerosed gall-bladder or a dilated common duct containing a stone can be seen. I know nothing in surgery which approaches such cases in difficulty, or which requires such care, gentleness, patience, and skill on the part of a surgeon. I sometimes hear the operation for the removal of a Gasserian ganglion or the avulsion of its sensory root spoken of as 'difficult'. It is work for a novice compared with that in many a gall-bladder case. Apart from cases such as these, which require firm handling, the amount of reaction is negligible. More than half the abdominal cases, except for a little flatulence, hardly realize that they have had an operation performed. Flatulence is a troublesome complication, not only of abdominal, but of other operations also. Its cause is uncertain. My own view is that it chiefly results from the starvation and purgation which are almost universally considered a necessary part of the ritual of deliberate operations. Both are certainly undesirable, and are possibly harmful. Solid food is much like liquid food by the time it gets well on its way in the jejunum. As much fluid as the patient wishes to have should be allowed to within an hour or two of the time arranged for any operation, and as soon as possible afterwards. Operations on the stomach are no exception. An enema generally clears the colon quite as much as is necessary. Aperients increase the number and the virulence of the intestinal micro-organisms, and are apt to deprive the patient of large amounts of fluid and to cause exhaustion: effects which are all most undesirable.

With the kind of wound just described there is a far greater general reaction and a higher degree of discomfort or of pain, and there is a greater likelihood of complications,

grave or trivial, such as phlebitis, thrombosis, the late discharge of buried ligatures or sutures, or the recurrence of the condition which originally required operation.

Surgery should be a merciful art. The cleaner and the gentler the act of operation, the less the patient suffers, the smoother and the quicker his convalescence, the more exquisite his healed wound, and the happier his memory of the whole incident, to him probably one of the most important in his life. The results of our ritual are therefore expressed not only in the mortality—where the difference may be slight—but also in the quality of the healing of the wound, and in the quality of the recovery from the operation, in respect of security, rapidity, smoothness, completeness, and finality.

In the ritual of a surgical operation the mysteries are imposed not only upon the high priest and upon the acolytes, but upon the congregation also. Every visitor to an operation theatre takes a part, however remote, in the operation. He is gowned, masked, and his head covered with a cap nowadays in all clinics. But dirty boots and soiled trouser legs, conveying mud, dust, and fæcal matter from the streets, are often unnoticed. If the wearer of them moves about the theatre freely, or goes from one theatre to another, the organisms carried in the drying filth are scattered broadcast, as the simplest experiment will prove. Large canvas overalls for the boots and the lower part of the leg, tying just below the knee, as a sort of legging, will afford ample and secure covering to this possible source of infection.

The surgeon and his assistants (the fewer the better) should of course change all their external garments before operation. The trousers and coats we all wear are very dirty. What would a pair of tennis flannels look like at the end of a week's wear in London? Our everyday darker garments do not show the same marks, but they carry the same dirt. White sterilized trousers, clean white shoes, or overshoes, sterile coat, cap and mask, all are necessary for the perfect outfit. They are much more comfortable to wear in a theatre adequately warmed, and there is a feeling of much greater freshness, both before and after an operation, when garments are changed. But I am, no doubt, like Jonah preaching to a converted Nineveh. All these matters are now a part of our daily routine.

The method of the preparation of our hands and arms is important. It is still a common thing to see hands washed in a basin of still water. The moment the hands are soaped and rinsed the water is polluted by the dirt washed off the skin. If the washing is continued it is obvious that the hands are being constantly re-infected from the contaminated water. If the water is emptied away, and fresh poured in, the basin, being polluted by the water it formerly contained, defiles the fresh water. And it is really not uncommon to see a piece of soap used to lather the hands, laid down, and picked up again, regardless of the fact that each contact of the soap with something else is a possible method of soiling it. The best of all plans is to wash under running sterile water. Some years ago I had water-tanks made, to hold five or six gallons, fitted with a dispensary tap, and placed over gas-coils, so that the water contained in them might be boiled. When the water boils the tap is turned, and about a gallon of water allowed to run through to sterilize the tap, on the end of which a boiled plug is fitted until the time comes for use. In a hospital installation it is easy to arrange for the tanks to be sterilized by steam and to be cooled by water running through a coiled pipe in the tank. Water can be boiled for a quarter of an hour, and cooled sufficiently for use in five minutes. Over the tank is placed a tap for refilling.

Almost all commercial soaps are sterile. The outer surface of course may be polluted, but when this is washed or scraped away the exposed fresh surface of the soap is sterile. Two methods of using soap are simple and satisfactory: to use a tablet of any household soap which has been lying in a solution of acrosyl for half an hour; or to sterilize some green soft soap in a flat dish in the autoclave, and to rub off, time after time, with a sterile gauze swab, enough of the soap to form a good lather. After washing for not less than fifteen minutes, the hands should be gently rubbed with gauze wet in spirit and biniodide solution, or in a solution of acrosyl, which is the antiseptic least likely to damage the skin. There is a great difference in the facility with which a hand can be cleaned; some rough chapped hands, coarsened by antiseptics, clean with great difficulty; smooth hands, well cared for, are sterile very soon. A surgeon's hand should be always carefully tended;

nails should be kept clean and short and smooth, and the skin like satin. Once a week or so a visit to a manicurist is desirable.

Gloves are almost universally worn during operations. I know only three surgeons the world over who are in the first rank who do not constantly wear gloves during operations. The arguments in favour of their use are unanswerable. A glove properly prepared is sterile, and remains so if put on the hand without its outer side being touched by anything except the glove of the other hand or a piece of sterile gauze. With practice it is rare to puncture a glove except in bone operations, and for these it is often an advantage to wear thin cotton gloves over the rubber. If a puncture does occur, a finger stall may be put on, or the glove changed in a few seconds. The bare hand is difficult to sterilize in some cases; it is almost impossible to keep it sterile throughout an operation, as the silk-thread experiment of Kocher shows; if it is infected during an operation it can certainly not be used uncovered again with safety during that operation.

A surgeon may say that he uses gloves only for septic cases. Does he always know when an operation, or any stage in it, is to be septic? If he inadvertently soils his hand when a septic area is unexpectedly discovered, does he then put on gloves? Has he them always ready to wear? Or does he use an antiseptic in the hope of combating the infection which he spreads with every touch? Is not the simpler, safer, more certain way to wear gloves which are certainly sterile, and to change them when there is any doubt as to their defilement?

But about the wearing of gloves a good deal may be said. Often they are a mere fetish. How often are gloves put on without their outer surfaces being touched, or stroked by a bare hand? How often are they considered rather a protection for the surgeon than for the patient? I have seen gloves put on carefully, and the gloved hand then used to palpate an abdomen imperfectly smeared with iodine. I have seen a blanket which covered a patient's legs pulled up towards his body by a gloved hand which a few minutes later was inside the patient's abdominal cavity; and I have seen cleaned hands gloved, and unclean forearms left bare, on more than one occasion. I have seen gloves used in the earlier stages of operation, and removed when a difficulty arose in, say, an operation upon an enlarged thyroid gland, or an operation for hernia. This is a technical sin of the gravest kind. Gloves may be sterilized by boiling, or be placed in the autoclave with the dressings and swabs and used dry. The advantage of the dry glove is that it is more comfortable to wear during a long list of operations, and that the hand being covered by a dry sterile powder is kept free from moisture. A chance puncture of the glove does not involve the escape of a possibly contaminated fluid into the wound. Gloves should be kept on the hands till the dressing of the wound is complete, and until the coat and sleeves are removed. If gloves are properly sterilized and properly put on, the covered finger may be used to explore a knee-joint or anywhere else with impunity.

The 'knife-and-fork' method of operating, in which only instruments are handled for every purpose, including the tying of ligatures, is a confession that the gloves cannot be trusted by the operator. If the bare hand is used during operations there is a risk which approaches certainty that the wound will be contaminated. This contamination may be lessened in its malignancy by the immediate application of antiseptics, or by the free and frequent washing of the hands in a bactericidal solution; but the results either of mild contamination or of the irritation of antiseptics in the wound are expressed in those qualities of its healing to which I have referred. Many years ago, before I began to use 'tetra' cloths to cover the skin around the wound up to its edges, we found that when cultures were taken from a wound they became progressively more numerous the longer the incision remained open; but many an infected wound healed by what we were then content to call 'first intention'. We soon learnt that there was a degree of 'clinical sterility' of a wound which was far removed from the 'absolute sterility' which it should be our endeavour always to secure, and which alone allows of 'perfect' flawless healing and a convalescence free from suffering. Above the gloves worn by all those directly engaged in the operation no bare arm should be seen. Either a long-sleeved gown should be worn, or sleeves which fit firmly round the wrist, there to be covered by the cuff of the glove.

Among the more important questions involved in the ritual of a surgical operation is that concerned with the preparation of the skin. The skin does not always, indeed does not often, harbour organisms, either on the surface or in the depths of sweat or sebaceous glands, of any special septic malignancy; but one can never be certain to what contact the skin has been subject, and therefore it is always uncertain whether septic organisms or spore-bearing bacilli are present or not. It is always necessary so to prepare the skin for a wide area around the wound to be inflicted that, so far as is humanly possible, no contamination of the wound shall be caused from this source. Infection may be conveyed to the skin of the surgeon's hands by the examination of discharging wounds, by rectal or vaginal or buccal examinations, or during an operation. This possibility should be prevented by the avoidance of any contact with patients, in these circumstances, unless gloves are worn. The principal of 'abstinence' is the safest: the surgeon abstains from soiling his hands by contact with any potentially infective agent.

It is exceedingly difficult so to sterilize the human skin that it will long remain sterile, as all the experiments conducted in recent years have shown. When a germicidal solution is applied to the skin, there is a 'clean fight', so to speak, between the sclution and the germs lying in or on the skin. The value of the solution as a germicide is therefore easy to test, and results obtained by these experiments may be accepted as of great value. It is far otherwise when a germicidal solution is applied to a wound, especially to an open wound a few days old, wherein reparative processes have begun. In such a wound an innumerable number of side contests are introduced; it is no longer a fight between a germ and a germicide. There are the cellular and the fluid contents of the wound discharge, and the various actions and reactions produced among them, the wound surfaces, the dressings, and the germicide all to be taken into account. It is a matter of interest to consider whether we do not go far astray when we assess the value of a germicide in an experiment *in vitro*, and then expect an equivalent germicidal action to be produced in an open wound. It is, I think, very doubtful whether the 'antiseptic' action produced by the addition of a particular chemical substance to a wound is due to those properties which it possesses as a bactericide. It probably possesses other properties also which are not strictly related to its germicidal power. But in the case of the skin no such perplexing problems arise. The efficacy of any germicide can be tested quite easily; and the results of experiments should here guide our practice. A surgeon may say that he is satisfied with the healing of his wounds when he might quite easily have better results by using better methods of skin sterilization. By clinical experience, which is tedious and lengthy, we may at last realize the value of skin disinfection, which we might have determined at once by experiment. By experience we find a short way by a long wandering.

What are the requirements for an ideal skin disinfectant? It should be cheap and easily accessible, simple in its application, non-irritant, capable of penetrating the skin to some depth; it should be effective in destroying in a short time all of the organisms which are found on or in the skin, and it should do nothing to prevent or delay the clean and speedy healing of the wound.

The skin disinfectant most commonly employed is iodine. It is applied in varying strengths, and in different vehicles—spirit, chloroform, acetone, benzine, etc. The tincture of iodine is the form which is most often used. Both experimentally and clinically the method is clearly of the second rate. The work of Tinker and Prince, Hunter Robb, Stanton, and others, shows that even when the iodine is allowed to remain on the skin which is tested, sterilization is not always indicated by the culture tube; if the iodine is removed by a solution of potassium iodide, and the skin washed with sterile water and examined, infection is demonstrable in over 50 per cent of cases. A very large proportion of the iodine used often disappears from the skin before the operation is completed. There is nothing then to recommend iodine but the ease and rapidity with which it can be applied and its colouring of the skin; its efficacy is far less than is required, and it is a powerful irritant. Iodine, to be effective, must be applied on a dry skin, which often means a dirty skin. I have more than once seen a smear of iodine applied over grime and filth that could not be sterilized by a dozen similar applications. I have used iodine myself on a great

many occasions, and have given it a fair trial; I have seen it in a very large number of clinics; yet I have very rarely seen a wound heal with all those attributes which are necessary before one is entitled to say that it is 'perfect', when iodine alone has been applied. Picric acid in alcoholic solution of a 3 per cent or 5 per cent strength gives better results than iodine; but it does not penetrate deeply, and it is not of sufficient bactericidal value. The wounds are, again, not up to the highest standard in a large number of cases.

By far the best method of preparing the skin that I have ever used—and I have tried and tested many—is carried out in three stages: (1) Abundant washing with soap and water, preferably ether soap; (2) Gentle friction with biniodide of mercury and spirit solution 1–500; (3) Drying; followed by the application for two to three minutes of Harrington's solution. When the towels are fixed round the operation area a further application of Harrington's solution is made; and throughout all operations the skin is covered with towels so that no friction of the hands against it is possible. It would be well if surgeons the world over took a little more pride in the wounds they inflict. The appearance of a wound is often the best index to the quality of the work that has been done throughout the operation.

The towels, which should surround the operation area as closely as possible, are fixed to the skin by clips. On the surface of the skin left exposed, a series of tiny scratches are made by a very thin needle, at right angles to the proposed line of incision. These are for the purpose of indicating where the stitches are to be introduced when the wound is sutured. Unless there is a mathematical accuracy of apposition there is never perfect beauty in a wound or scar, and accuracy of apposition is difficult or impossible unless some method of this kind is adopted to secure it.

In so far as the actual operation is concerned, it is, for the reasons I have given, essential to avoid contact with the skin of a patient as much as possible. The hands should not touch the skin at all, viscera should not be allowed to lie upon it, and the rubbing of instruments against it must be avoided. As soon as the incision is made, cloths of several thicknesses of gauze or towelling are fixed to the skin edges and dip well into the wound. If these 'tetra' cloths lie loosely on the parts around the wound, they ruffle up during the movements of the surgeon's hands. If powder is dusted on the under surface of them it is soon found to lie in the wound. The towels must therefore be held at points distant from the wound, so that they are kept stretched and fixed throughout the operation. When they are removed at the conclusion of the operation, the skin covered by them is washed over with spirit and with Harrington's solution before any stitches are inserted.

The wound is made by a firm, clean sweep of the knife. Any bungling here makes an irregular, ugly wound. A good many of the scalpels made nowadays are peculiarly unfitted for their work. I use only two patterns: one with a deep belly, made for me by Stille of Stockholm originally, and the other Stiles's pattern, which is used for all dissections. All vessels are clipped if possible, as in a hernia operation, before being cut, but certainly the moment they are cut. If blood leaks into a wound it stains the tissues, and makes subsequent dissection along the 'white line' very difficult.

I say that 'vessels' are clipped. Most of the clips made seize not only the vessels but a mass of tissue surrounding them. When ligatures are applied, all this tissue is strangled in the ligature, and has to be digested by leucocytes in the wound. The tips of artery clips should be narrow—almost pointed—and should seize the very smallest possible portion of tissue with the vessel. If dissection is carried on in a wound, as when glands of the neck, or of the breast in a case of carcinoma, are removed, gentle traction in one direction by the surgeon, and in the opposite by his assistant, will reveal a fluffy layer of thin areolar tissue, the 'white line' as I always call it, along which dissection can proceed very easily and quickly, and with the immediate disclosure of all the vessels which must be seized. This involves the application of many clips, but the wound should always be kept dry and unstained by blood. Kocher was accustomed to put out twenty dozen clips for a goitre operation, and on many occasions he seemed to use most of them. It

should be our ideal to complete such an operation, which in my student days was often one involving much loss of blood, without staining the towels round the wound.

Though traction is necessary in gland and goitre operations, it must be avoided in abdominal work. There every pull means a pain. I dislike abdominal retractors intensely. The forcible and merciless retraction of the abdominal wall throughout a long operation cannot fail to cause shock and suffering afterwards. The best retractor is the gentle light hand of a well-trained assistant, used mercifully when it must be used at all. But with adequate incisions, retraction is very little needed during the greater part of most operations.

Dissection may be carried out in two manners: by the knife, or by 'gauze stripping'. If by the knife, the movements should be short, sharp, close together, so that if recorded on a moving drum the picture would resemble a 'feather edge'. And the knife must be sharp. Big, heavy, clumsy movements with a dull knife hurt the patient, and leave the parts less fitted to heal. Throughout the operation there must be no undue exposure of parts. In a large dissection, such as that required in removal of a cancer of the breast, the dissection extends from the axilla to the umbilicus, and from the opposite pectoral muscle over the latissimus dorsi. With skin flaps turned back, the bared area is very extensive. It should never be seen as a whole. As one part of the dissection is completed, hot moist mackintosh cloths are placed over the raw surface to prevent drying and chilling, and the chance of contamination. Similarly, in abdominal work, only that part of the operation field should be seen with which the operator is at the moment engaged. There is no need in the operation of gastro-enterostomy, for example, for anything to be outside the abdomen during the suturing of the viscera except that small part of each which is embraced by the clamps. The patient is accustomed to keep his own viscera warm, and he should still be allowed to do so. Crile's work has shown, to my mind conclusively, the need for avoiding cooling or drying of wound surfaces.

All the instruments used during the operation are of course sterilized by heat; but it is important to remember that contamination may occur during an operation, and therefore the various clips, scissors, retractors, or other instruments should be re-sterilized as often as is necessary. If, for example, a pair of scissors are used to open the intestine in a case of gastro-enterostomy or colectomy, or needles to suture viscera together, they are at once discarded, and never used again till they have been boiled. The mucosa may be sterile in a case of gastro-enterostomy, but one can never be certain, and it is safer always to assume that any possibly infected tissue *is* infected.

In operations for malignant disease, frequent sterilization of instruments is most necessary. For example, in removing a breast for carcinoma, many surgeons, of whom I am one, adopt the method suggested by Rodman and Willy Meyer, and complete the axillary dissections first. There are many advantages in so doing which need no mention now. Every instrument used in this dissection—knife, clips, scissors—may possibly be brought into contact with a cancer cell. When once used it is therefore laid aside, and not taken up again till it has been re-boiled. Cancer cells, as Ryall and others have shown, can be grafted on to the patient's own tissues and develop a new deposit of cancer. It is obvious that the graft may be conveyed on any instrument, or on the gloved hand if it is at work in the wound. In all operations I have a red handkerchief placed on the table which lies over the legs of the patient. As soon as any instrument is soiled I place it on this danger spot, and it is at once removed by the nurse to the sterilizer.

As regards the material used for ligatures and sutures which must remain within the wound, certain conditions are essential. Such material should, ideally: (1) Achieve its purpose—be sufficient to hold parts together, close a vessel, etc.; (2) Disappear as soon as its work is accomplished; (3) Be free from infection; and (4) Be non-irritant.

The only material which can be made to fulfil these conditions is catgut. Catgut can be sterilized perfectly. The method of Claudius, which directs that the catgut should be soaked in a solution consisting of iodine 1 per cent and potassium iodide 1 per cent in water, ignores the faet that with such a proportion of iodide of potassium all the iodine is not dissolved; much of it lies inert at the bottom of the vessel. I use a solution made

in accordance with their atomic weights, iodine in a strength of 1 per cent and iodide of potassium in a strength of 1·75 per cent; the whole of the iodine is then taken up, a darker and stronger solution results, and catgut soaked in this for ten days or more is almost black in colour, and so strongly permeated by iodine that it is exceedingly difficult to infect it. I have never known any surgeon use silk and not have trouble from it. Silk for ligatures is not necessary, for catgut will securely tie any vessel. Silk for intestinal sutures is not necessary. Certainly I have not used any for fifteen years, and I have now discarded linen thread for all but the anastomoses after colectomy. An unabsorbable suture used to effect the junction in gastro-enterostomy is possibly a factor causing the development of a jejunal ulcer. But thick chromic catgut also will remain for years at a suture line in such a case. In one patient I have found a piece of chromic catgut over two inches long dangling at the gastrojejunal opening three years and nine months after the anastomosis had been made. It is of, course, as I have before pointed out, the sero-serous suture which is the offender in such instances. The inner mucous suture, no matter of what material, is soon loosened and escapes.

Probably we all use more sutures than are necessary in intestinal anastomoses. In urgent cases I have more than once used a single Connell suture with perfect success. But in surgery, in order to be certain that you have done enough, it is generally prudent to do more than is necessary. Over and over again I put in an additional stitch here and there. I know it is not really needed, but I call it my 'hypnotic' stitch; for I sleep better at night when I know it is there.

The most important person present at an operation is the patient. This is a truth not everywhere and always remembered. It is our duty to make the operation as little disagreeable as possible for him. To many patients it is a dreaded ordeal. Our patients to-day are terrified by the tradition that clings to the word 'operation', a tradition started in the days when it must indeed have been a terrible procedure, without anæsthetics other than those stupefying drugs, alcohol and tobacco, with patients strapped down or held by assistants, and all the other horrible accessories. To-day an operation can, and should, be made a very simple matter, devoid entirely of anything repellent or disheartening.

The preliminary use of scopolamine, atropine, and morphine, or of omnopon, is a very valuable help. One dose of $\frac{1}{120}$ gr. atropine and about $\frac{1}{100}$ or $\frac{1}{150}$ gr. scopolamine and $\frac{1}{6}$ or $\frac{1}{4}$ gr. morphine is needed, according to the patient's age, size, etc. This is given about three-quarters of an hour before operation. In a private hospital the blinds should then be drawn down, the room darkened, and the patient encouraged to sleep. No talking is allowed. The nurse remains in the room, but is warned not to speak, and of course no friends are then permitted to see the patient. When the patient is taken to the operation theatre as quietly as possible, a towel covers the eyes and the operation room itself is dark. No conversation is allowed in the theatre, and only the anæsthetist and one nurse, or possibly two nurses, remain. Everything is kept as quiet and orderly as possible. About one-third of the patients subsequently say they have little or no recollection of going to the theatre or of taking the anæsthetic. All abdominal cases are treated by Crile's method of quinine and urea injections into the parietal peritoneum, and into the nerve-trunks running to the area in which the operation takes place. There is no doubt as to the diminution of pain thereby resulting. With shock we are not much concerned. There are very few occasions indeed when shock results from an abdominal operation properly conducted, when the patient is kept warm on the table by one device or another, and when the gentlest handling, the most careful hæmostasis, and adequate protection of parts have been exercised.

Every detail in every operation is of importance, and should be conceived, practised, and tested with unwearying patience by the operator himself, and by him in conjunction with all his assistants. Was it not Michael Angelo who first said that success depends upon details, but success is no detail? In surgery, at least, success may well depend upon the scrupulous, exacting, and unceasing supervision and close scrutiny of every smallest incident of procedure. In respect of surgical work there may be some truth in

Blake's assertion that all excellence is in minute particulars. Surgery is nowadays no longer the work of an individual, but of a 'team' in which every member plays his exact part, in which all contribute to success, and in which each may bring about disaster. The well-trained team should display that mastery which is implied by ease in smooth and efficient action. In every phase of its work there should be, not merely the casual observance of a ritual the meaning of which is lost and the deeds of which are only a faded counterfeit, but acts of full devotion to principles which have been tried and proved, acts which are the witnesses to a living and perfect faith.

It is of course a platitude to say that a good surgeon is not merely one who operates well. The qualities required to make our ideal surgeon are many: gifts of character, leadership, wisdom—even worldly wisdom—compassion, and the finest technical skill. In respect of the latter we remember that surgery is not only a science but an art, work demanding the highest craftsmanship, and a knowledge of all the "tricks of the tools' true play".

In all the movements of the surgeon there should be neither haste nor waste. It matters less how quickly an operation is done than how accurately it is done. Speed should result from the method and the practised facility of the operator, and should not be his first and formal intention. It should be an accomplishment, not an aim. And every movement should tell, every action should achieve something. A manipulation, if it requires to be carried out, should not be half done and hesitatingly done. It should be deliberate, firm, intentional, and final. Infinite gentleness, scrupulous care, light handling, and purposeful, effective, quiet movements which are no more than a caress, are all necessary if an operation is to be the work of an artist, and not merely of a hewer of flesh. For every operation, even those procedures which are now quite commonplace, should be executed not in the spirit of an artisan who has a job to get through, but in the spirit of an artist who has something to interpret or create. An operation should not only bring relief or health to the patient, but should give a glow of keen delight to the artist himself, a thrill of joy and a sense of complete satisfaction to a critical spectator.

Ours has been a necessary profession ever since man's body was subject to enmity and casualty. All who practise it will need the gifts of which Thomas Fuller spoke—"an Eagle's eye, a Lady's hand, and a Lion's heart". Of all of us who labour honestly may it at last truthfully be said, as it was said of James IV of Scotland, "Quod vulnera scientissime tractaret"—"He was most skilful at the handling of wounds."

# THE RÔLE OF RADIUM IN THE TREATMENT OF MALIGNANT DISEASE OF THE BLADDER AND MALE GENITAL ORGANS.

By CLIFFORD MORSON, London.

The progress made in this country during the last decade in the knowledge of the effect of radium upon human cells, normal and pathological, is not fully realized by the generality of the medical profession. Facts are gradually becoming known which in the near future will improve the technique of the treatment of malignant growths by radium, and in consequence yield better results than those which have been previously attained. While discussing the employment of radium in the treatment of cancer of the bladder and male genital organs, it should be borne in mind that the principles which apply to the treatment of growths in these organs apply equally elsewhere.

**Effects of Radium upon Normal Tissues.**—Definite degenerative changes are produced in the cells of the normal tissues of the mucous membrane and skin when exposed to radium irradiation. When a malignant growth of the mucous membrane of the mouth is exposed to the rays, their influence upon the normal mucous membrane will be apparent. The writer has studied these changes macroscopically and microscopically. The naked-eye appearance is instructive; the pinkish colour of the mucous membrane is replaced by a grey hue, not unlike that seen in the early stages of leucoplakia of the vulva or anus. Gradually a film of this grey colour forms, which finally separates from the underlying tissues, leaving a shallow ulcer. The latter is tender, painful, and heals slowly. Microscopic examination of the film reveals the superficial cells of the mucous membrane undergoing keratinization. The process is similar to the changes seen in the early stages of leucoplakia, which latter is well known as a pre-cancerous condition. With regard to the effect of radium upon the skin, Becquerel and others experimented upon themselves, and produced an inflammatory condition, followed by ulceration. Five years ago the writer had personal experience of exposure to the gamma rays. As a result of handling radium daily over a period of two months, changes occurred in the skin of the forefinger and thumb of the right hand, causing a temporary loss of tactile sensation, with marked sensibility to heat and cold. Further reference will be made to the damage to normal tissues when describing the application of radium to growths of the bladder and prostate.

**Sepsis in Relation to Radium Irradiation.**—When this serious complication arises, the natural resistance of the patient disappears and the spread of the disease is rapid. Clinical experience demonstrates that the sensitiveness of the malignant cell on exposure to the rays is in direct proportion to the activity of its reproductive power. It might, therefore, be argued that the introduction of sepsis would favour the rapid destruction of the malignant cell when exposed to irradiation. However, the contrary occurs. Bacteria, when exposed to the gamma rays of radium—and it is the gamma radiation which is used chiefly for therapeutic purposes—are not destroyed unless the exposure be very prolonged. Strassmann performed numerous experiments in 1904 which showed that streptococci could only be killed by 10 mgrms. of radium with exposure of twenty-four hours, the screen used being mica. With a screen of mica and glass the exposure needed was thirty-six hours. In his experiments the beta rays were used as well as the gamma. Experiments by Russ and Chambers,[1] on lines somewhat different from those adopted by Strassmann, confirm the latter's observations. In 1914, with the assistance of Sidney Russ, the writer attempted to cure gonococcal urethritis by means of an active wire of platinum. The dose was equivalent to about 10 mgrms. of the radium salt; the mucous membrane of the urethra was exposed to the alpha, beta, and gamma rays for about a

quarter of an hour. Not only did such treatment fail to destroy the gonococci, but the inflammatory reaction in the mucous membrane was so severe that further experiments on these lines were inevitably abandoned.

Let us turn to the data collected on the effect of radium upon leucocytes, the most efficient constituent of the blood in fighting bacteria.

Russ and Chambers[1] measured the phagocytic power of the leucocyte in a specimen of blood, and then at various times after exposure had begun to a concentration of 1·6 millicuries per c.c. The results obtained showed that an eight-hour exposure reduced phagocytosis by 46 per cent. Prolonged exposure led to the complete disintegration of the leucocytes. Of the different varieties of leucocytes, the lymphocytes were the most sensitive and therefore the most readily destroyed. Thus the phagocytic power of the leucocyte when exposed to the gamma rays of radium is gradually reduced, and prolonged exposure leads to its complete disintegration.

These experiments indicate that, when radium is used clinically, a large dose with prolonged exposure must be employed to remove organisms from a septic growth. But while this lethal dose is being applied, the rays are slowly undermining the power of the leucocyte to deal effectively with the invading bacteria. Thus the action of radium in destroying bacteria is neutralized by the harm it does to the leucocyte. Moreover, the danger of severely damaging the normal tissues around the tumour by such a large dose is not inconsiderable. The writer's clinical experience is that the spread of a growth is hastened by radium irradiation if sepsis is introduced.

## MALIGNANT GROWTHS OF THE BLADDER.

There are four different methods whereby radium can be employed in the treatment of such growths. These are as follows: (1) *Surface application;* (2) *Internal application;* (3) *Combined surface and internal application;* (4) *Burying of radium in growth.*

1. **Surface Applications.**—Radium, put up in plates, is applied to the skin of the suprapubic region. Thus a considerable thickness of normal tissue intervenes between the radium and the growth. The main criticism of this procedure is that, apart from the danger of producing degenerative changes in these tissues, the greatest intensity of irradiation falls, not upon the growth, but upon the skin and underlying structures of the anterior abdominal wall.

2. **Internal Application.**—

*a.* A suprapubic cystotomy is performed and the radium dropped into the bladder cavity, where it must come in contact with the normal mucous membrane.[2] As at least an eight-hour exposure is necessary to destroy the malignant cell, it will be obvious that the changes in normal mucous membrane, described previously, will occur.

*b.* The radium is passed per urethram and placed broadside on the tumour by means of a special instrument devised by H. H. Young and W. A. Frontz, of Baltimore.[3] This instrument is tubular, and an observation cystoscope can be passed through it, enabling the operator to apply the radium accurately. But, apart from the damage to normal tissue, there is the discomfort of keeping a metal instrument in the urethra for eight consecutive hours.

3. **Combined Application.**—Radium is inserted into the rectum, and as far as possible kept in contact with its anterior wall in the region of the base of the bladder. At the same time radium is applied to the skin of the suprapubic region.

This method is to be deprecated on account of the reaction produced in the mucous membrane of the rectum. Pain and tenesmus follow the introduction of radium into the bowel, and cause great distress to the patient. Even Young, who advocates this method, admits its dangers; but he claims that these sequelæ can be avoided if the dose is carefully regulated and not frequently applied to any one spot.[3]

4. **Burying of Radium in Growth.**—A suprapubic cystotomy is performed and the radium buried in the substance of the tumour. The pioneer of this mode of exposing malignant cells to irradiation was Dominici, of Paris, whose untimely death must be a

cause of deep regret to those who wish to see radium therapy placed on a more scientific basis. The writer has adopted this method as giving the best results in the treatment of malignant disease of the bladder and male genital organs. It is important that the suprapubic cystotomy should be performed as early as possible, and the growth thoroughly irrigated with antiseptics twice daily for a week. Sanitas, one drachm to the pint, is non-irritating and yet causes the removal of sloughs from the surface of the growth. At the end of this time sepsis in the growth will be appreciably reduced. The suprapubic wound is then opened up further, and the radium tubes are buried in the tumour in the region of the periphery, where the cells are undergoing the most rapid development. So soon as the skin wound has healed, an apparatus for permanently draining the bladder above the pubes should be applied. This consists of a curved metal tube which passes through a metal shield and fits on to a rubber tube which terminates in a rubber bag fixed to the inner side of the thigh by straps. Thus the patient is able to walk about in a moderately comfortable condition.

**When Radium Irradiation is Justifiable.**—In relation to malignant growths of the bladder this is a question of considerable importance. In expert hands partial cystectomy has given excellent results, and as yet no data have been brought forward to show that any other method of treatment can compete successfully with operative measures. But to ensure the patient a bladder capacity which will give him an undisturbed night's rest, there is a limit to the amount of bladder wall which can be removed. Life is intolerable to the man who is compelled to micturate every half-hour; and if, in order to cut free of the growth, it is necessary to remove as much as two-thirds of the bladder, then, in the opinion of the writer, excision is not the best treatment. In radium we have a remedy which can be adopted in these advanced cases with a certain measure of success.

The following changes occur on exposure of the malignant growth to the rays: (1) Rapid degeneration of the malignant cells in the immediate vicinity of the tube of radium; (2) Apparent vacuolation and enlargement of nuclei of those cells beyond the degeneration zone; (3) Loss of the reproductive function of the cancer-cell; (4) Proliferation of the connective-tissue cells, which change shows a similarity to the attempt of nature to arrest the development of cancer through new formation of fibrous tissue; (5) Thrombosis of the blood-vessels, which leads to the arrest of hæmorrhage and shrinkage of the malignant mass.

Such alterations in the character of the tumour cause both an improvement in the local condition and a beneficial effect upon the general health, with prolongation of life. But should an excessive quantity of radium be used, or too prolonged an exposure given, not only will necrosis of the whole tumour result, but also the normal tissues will slough.

## MALIGNANT GROWTHS OF THE PROSTATE.

The methods of applying radium to such growths are: (1) *Internal application*—(*a*) per rectum, (*b*) per urethram; (2) *Burying of radium in growth.*

1. **Internal Application.**—(*a*) The danger of placing radium in apposition to the rectal mucous membrane has already been considered. (*b*) A similar disadvantage is encountered when radium is inserted into the prostatic urethra. The latter becomes inflamed, and frequency of micturition is marked.

2. **Burying of Radium in the Growth.**—The patient, under general anæsthesia, is placed in the lithotomy position. A sound is passed per urethram into the bladder, and an incision made along the median perineal raphé. The tissues between the anterior wall of the anal canal and membranous urethra are then separated. By inserting the finger into the space between the anal canal and membranous urethra the lower pole of the prostate is felt. With the finger as guide, the radium tube is passed into the substance of the gland between the urethra in front and the rectum behind. To obviate the necessity of using a knife, the tube should have one end pointed. Care must be taken that the radium is not pushed into the urethra; the presence of the metal sound should be of assistance in avoiding this error.

So long as the disease has not spread beyond the capsule of the prostate, removal of the growth by operation is the correct procedure ; but when it has infiltrated the surrounding tissues, e.g., the base of the bladder and the vesiculæ seminales, the use of radium is indicated. The latter treatment will reduce hæmorrhage, because of the sensitiveness of the endothelium to irradiation, which causes thrombosis and thus interferes with the vascular supply of the growth. This is followed by a shrinkage of the tumour and reduction in the frequency of micturition.

**Malignant Disease of the Penis.**—A growth of the penis can be so readily removed by operation, and with such excellent results, that treatment by radium at the present development of our knowledge is contra-indicated.

**New Growths of the Testicle.**—Inoperable cases only should be subjected to irradiation ; and such treatment depends upon the extent and anatomical position of the malignant growth. It is only when the secondary deposits are confined to the iliac fossæ that radium is likely to bring relief to the patient. When the disease has spread to the glands along the inferior vena cava and beneath the liver, causing gastric disturbance, no known remedy is of any avail.

*The Burying of Radium in Secondary Masses in the Iliac Fossa.*—Remarkably good immediate results may be observed from this procedure. The sensitiveness of malignant cells of a testicular growth is so great that a comparatively small dose of radium causes rapid shrinkage of the tumour. The burying of radium in a growth in the iliac fossa is a simple matter, and involves no shock to the patient. Under local anæsthesia an incision is made parallel with Poupart's ligament, and the growth is exposed beneath the skin and subcutaneous tissue. The radium tubes, with pointed ends, are pushed into the substance of the growth and left there from eight to ten hours, after which period they are removed and the skin wound is closed.

## CONCLUSIONS.

Little has been said about the dosage of radium, the aim being rather to discuss when and how it should be used in the treatment of malignant disease of the bladder and male genital organs. Reference to a previous article in the *British Journal of Surgery*[4] will give those who are interested in this subject the lines upon which dosage may be determined.

With the experience gained in recent years of the effect of radium upon malignant disease, there is one outstanding fact—radium is local in its action. The removal of a growth by radium does not ensure an immunity from recurrence in other parts of the body. The experiments on mice, which showed that the cancer cell when irradiated with a sub-lethal dose had the power to confer immunity against the same strain of tumour, have as yet failed when put to the test in the case of human malignant disease.

It is the type of growth which rarely gives rise to metastases that is most successfully treated by the rays of radium. Therefore in cases of malignant disease of the bladder and prostate a good result may be expected, provided always that the remedy be applied with meticulous care, and with an exact knowledge of the effect of irradiation upon the normal tissues of the body.

The author's thanks are due to Mr. Hayward Pinch, the Medical Superintendent of the Radium Institute, London, for the loan of emanation tubes for the treatment of his cases at St. Peter's Hospital for Urinary Diseases.

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# ACUTE ENCYSTED HYDROCELE OF THE SPERMATIC CORD.

By RAYMOND JOHNSON, London.

Several years ago, when I was seeing out-patients at the Victoria Hospital for Children, one of the employés at an exhibition being held in the neighbouring grounds of the Royal Hospital applied for advice in the following circumstances. Whilst at his work he was seized with sudden acute pain in the groin, and noticed a lump in the same position. There was nausea, but I do not think the patient had actually vomited. The history was negative, and the man was emphatic in his statement that the lump had only just appeared. On examination, a tense oval swelling was found, apparently projecting from the external abdominal ring. The case was regarded as one of strangulated inguinal hernia, and the man was at once sent on to a general hospital, where the same diagnosis was made and an immediate operation performed. I afterwards learned that the supposed strangulated hernia proved to be an encysted hydrocele of the spermatic cord.

Although perfectly familiar with the fact that an encysted hydrocele of the cord may, especially in a child, be confused with an inguinal hernia, I did not at that time know that such a hydrocele might appear so suddenly as to resemble a strangulated hernia; nor did enquiries help me until I found that the condition had been recorded by Curling (*Diseases of the Testis*, 1856, p. 160). The case is described as follows:—

> "A youth, age 15, was admitted into hospital on account of a supposed strangulated hernia. When three years of age he had been subject to rupture on the right side, and had worn a truss for two years, when it was discontinued, as the hernia seemed cured. On the morning of his admission he was seized whilst at work with pain in the right groin, and on feeling the part discovered a small swelling. As the pain was increasing, he returned home, and shortly afterwards vomited. A surgeon who was sent for applied the taxis, and failing to reduce what he supposed from the history and examination to be a hernia, sent the lad to the hospital, when he was again examined, and placed in a warm bath, after which I was summoned to perform an operation.
>
> "I found the lad with an anxious countenance, and affected with nausea. Just below the abdominal ring there was an extremely tense and tender oval swelling the size of a pullet's egg. It had a contracted neck extending into the inguinal canal, received no impulse on coughing, and the testicle was below and distinct from it. On examination by transmitted light the swelling was found to be quite transparent. I at once came to the conclusion that the case was an acute hydrocele of the spermatic cord, and by the application of leeches and ice to the tumour, and the administration of calomel and opium, all the symptoms were relieved. He was discharged in a few days, at which time the fluid had nearly disappeared. Above the swelling there was a slight hernial descent, for which a truss was ordered."

I regret that it has not been possible to find the full records of a second case which came under my care at the Victoria Hospital, shortly after my attention had been drawn to the subject. A child, about 5 years of age, was sent by a medical man as a case of strangulated hernia. The symptoms, which were only of a few hours' duration, consisted of sudden pain in the groin, vomiting, and the presence of a small tense swelling below the external abdominal ring. The diagnosis of acute encysted hydrocele was confirmed at operation.

No similar case presented itself until about a year ago, when I saw a medical friend in the following circumstances. About seven hours previously, whilst trying to start a

rather obstinate motor-car, he felt a sudden pain in the right groin, and a little later discovered a tense very tender lump in the same position. There was considerable nausea, but no actual vomiting. He suspected a strangulated hernia, and on applying at a hospital the same opinion was expressed and operation advised. When I saw the patient there was a tense oval swelling, of about the size and shape of the testicle, in the upper part of the right side of the scrotum. Both the testicles were normal. Hernia was excluded by the facts that the swelling was translucent and that the spermatic cord could be grasped with the finger and thumb between the swelling and the external abdominal ring. The diagnosis of acute encysted hydrocele was made, and the patient assured that with rest the pain and nausea would almost certainly subside, although the swelling might remain. This proved to be the case, and about three weeks later the cyst was tapped and an ounce of clear fluid withdrawn. It did not recur.

These three cases are evidently all examples of the acute form of encysted hydrocele of the spermatic cord so clearly described by Curling. The evidence in the last case is conclusive that the swelling was not appreciable at the moment of the onset of pain, but appeared a very short time afterwards.

The mode of onset, the character of the swelling, and the presence of nausea or actual vomiting, combine to make the resemblance to strangulated hernia very striking.

I am unable to offer an explanation of the condition, and can only suggest that a sudden pressure on the part produced by a forcible muscular effort is sufficient to cause an effusion of fluid into the already present unobliterated portion of the funicular process. The possibility that fluid might have been driven down through a minute opening communicating with a higher part of a bilocular cavity was negatived by the condition found in the second case. It had occurred to me that possibly a small hæmorrhage started the effusion, as is probably the case in many instances of acute bursitis ; but the fluid withdrawn in the second and third cases showed no sign of blood-staining.

It is hoped that the condition is of sufficient rarity and practical interest to justify this short communication.

# *VISITS TO SURGICAL CLINICS AT HOME AND ABROAD.*

## THE CLINIC OF SIR ROBERT JONES AT LIVERPOOL.

For some years past Robert Jones's clinic has extended from Aberdeen to London and from Belfast to Dublin. Before the War his chief centres of activity were Liverpool and London, and, now that the War is over, he is again chiefly engaged in these two cities. But as the work which has made him both loved and famous, and the tradition which he inherited from Owen Thomas, are products of the northern city, the present article is confined to a description of the work there.

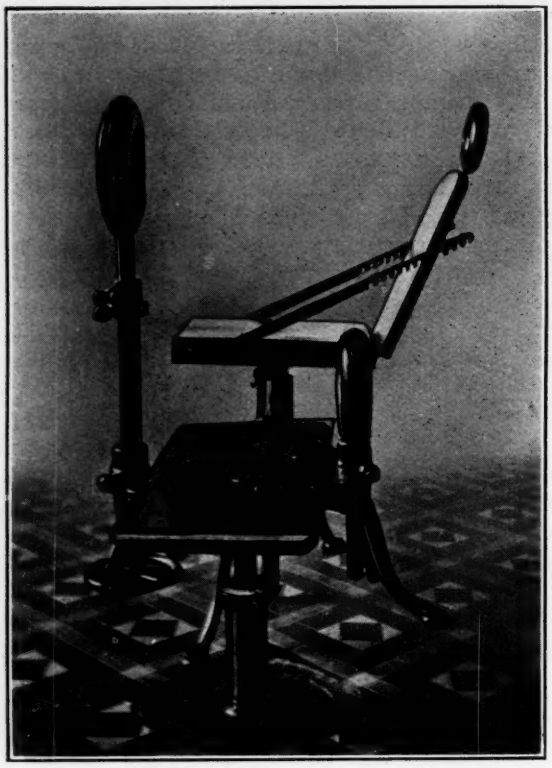

Fig. 20.—The old chair used by Hugh Owen Thomas.

Although his principal hospital appointment has been that of Surgeon to the Royal Southern Hospital, on the staff of which Jones has been assistant surgeon and surgeon since he was a young man of 21 years, he has also been attached to the Children's Hospital, and during later years the importance of this work has so claimed his attention that he has had to give up other hospital positions and devote himself to the crippled children, and to the founding of new hospitals in the country, more suitable than city institutions for their treatment.

The present writer was privileged to see Sir Robert doing his private as well as his hospital work, and it will be of interest, probably, to describe both, particularly because the former is so closely linked with the history of British orthopædic surgery as taught by Hugh Owen Thomas.

No. 11, Nelson Street, Liverpool, close to the Docks, was Thomas's home, and until a few years ago Jones himself resided there. To-day it is entirely devoted to the purposes of a private clinic, that is to say, offices for consultation, *x*-ray examination, and records. Critchley, the instrument-maker, has his workshops in an adjoining building, and by personal attendance secures accurate and speedy execution of prescriptions for all necessary appliances. The father of the present Mr. Critchley was a metal and leather worker, who was trained by Thomas to make the appliances invented by the latter.

In one of the ground-floor rooms there still stands the special chair with a ring attached to it which Thomas used for the reduction of old dislocations of the shoulder-joint (*Fig.* 20).

As it is only possible for Sir Robert to give two or three days in each week for private work, a great number of patients have to be seen on each occasion, and this necessitates a careful system of secretarial work for the making of appointments and preliminary taking of histories, together with the subsequent keeping of records and indices.

Six small rooms on the ground floor each accommodate one patient, and other rooms, formerly living-rooms, have now been converted into consulting-rooms, so that as many as thirteen patients can be prepared for examination at the same time.

Sir Robert Jones's office, from which all the work is directed, consists of a long studio-room, the walls of which are covered by photographs of eminent surgeons, notable medical caricatures, and anatomical models or casts. Here Sir Robert deals with letters sent with patients, and dictates answers to his stenographer with somewhat bewildering brevity and rapidity. After a short interval the nurse says that a patient is ready in No. 1, and Sir Robert goes with her to see him. On a clip outside the door is a card bearing the chief details of the case to be seen, and with these facts in his mind he goes in to see him and makes his examination. Most of the original consulting-rooms are very small, and arranged with severe simplicity—a couch and a chair being all the furniture, whilst on the wall is a cautery iron over the flame of a Bunsen burner. The preliminary note-taking by a trained assistant makes much conversation unnecessary, but Sir Robert, by his genial remarks made whilst the examination is proceeding, imparts an air of friendly intimacy to the interview which makes the patient and his friends feel that this is the most important case of the day. Details of immediate and after-treatment are given to the nurse; and if sometimes the consultation is over before the patient realizes that it has begun, yet all essentials are secured in the briefest possible time. Sir Robert then returns to his office, and dictates a letter to the medical man from whom the case came, and a note about the result of his examination for his own records (*Fig.* 21). He then goes to another patient.

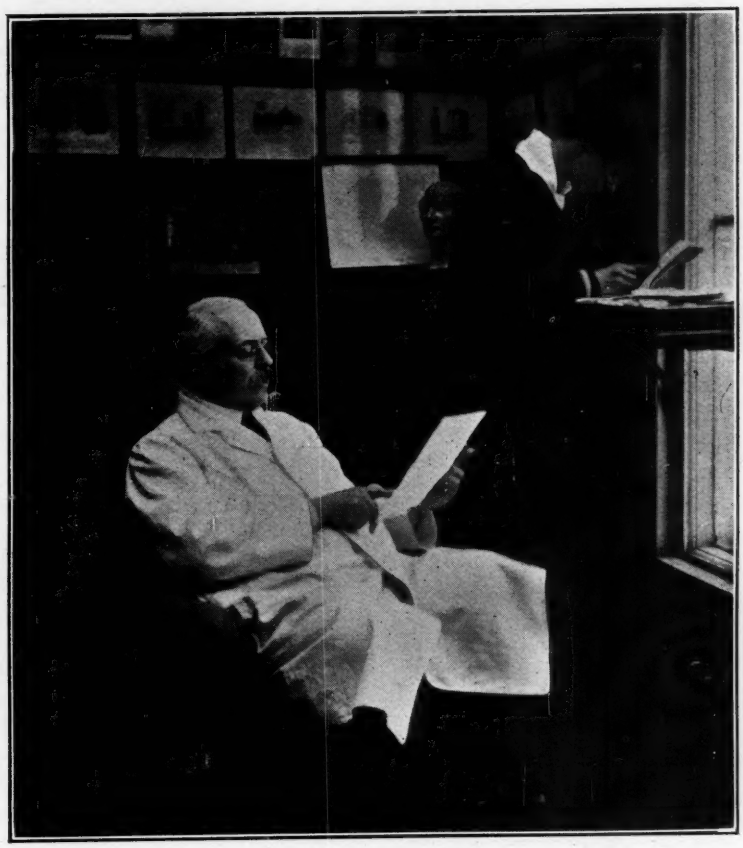

FIG. 21.—In the office.

The following are typical of the thirty-five patients seen whilst the writer was present:

A footballer from a neighbouring Lancashire town with an injury to the knee, having adhesions in the front of the joint.—Forcible flexion is carried out, and is to be repeated. Certain exercises are prescribed.

A gentleman with a painful back after a hunting accident.—A painful spot is found

over the origin of the right erector spinæ. Manipulation under an anæsthetic, followed by a special belt with a pressure pad over the painful spot.

A child with a weak foot from paresis of the external popliteal nerve.—Special massage and electrical treatment, with a boot raised on its outer edge.

A chauffeuse who had sprained her right wrist, with consequent limitation of rotation and flexion of the wrist.—Adhesions to be broken down under an anæsthetic.

A boy with weak mobile flat-feet.—Boots with raised crooked heel and outside irons; exercises and education; special bandages at night.

Child with spastic paraplegia, the toes being pointed and the legs adducted.—Tenotomy of Achilles tendon and adductors, to be followed by plaster and physical exercises.

A lady with the hip-joint ankylosed at right angles, after a septic infection incurred in 1915.—To have a subtrochanteric osteotomy.

Gentleman with both hips partially ankylosed; no real shortening, but 1½ in. of apparent shortening of the left leg.—Final advice as to treatment deferred until the result of *x*-ray examination was known.

A lady with painful heels, tender bursæ behind both tendines Achillis.—Bursæ to be dissected out.

In some contrast to the concentrated arrangements for consultations, the operative work for private patients is scattered among a number of nursing homes. Those which we saw were typical of the British nursing homes, i.e., they were ordinary dwelling-houses, more or less suitable or adapted for hospital purposes.

In the operative as in the consulting work, all the preliminaries and the after-treatment are arranged and carried out by assistants. The principal assistant who superintends the work in Sir Robert Jones's absence gives the anæsthetics for the operations, and the operative assistant is a nursing sister who has been in this service for many years and accompanies the chief to all his operations in or near Liverpool, in private or in hospitals. She practically organizes the operative programme in all its details of preparation and execution, and her perfect efficiency is one of the secrets of its rapid and smooth working.

Sir Robert follows the usual aseptic technique in regard to dress—he wears cap, mask, overalls, rubber boots, and boiled gloves, while visitors are clothed in cap, mask, gown, and canvas foot and leg covers. The following are brief notes of the four operations which Sir Robert did during the visit of the writer:—

1. Removal of Internal Semilunar Cartilege. *Time of operation*: 9.50 to 10.10.—An adult male, who had had done elsewhere three previous operations for internal derangement. A tourniquet was applied to the upper thigh, and the knee bent over the end of the table, the operator sitting. Incision oblique from above downwards and inwards 1½ in. long. There was much venous oozing, which hindered a good view of the joint. The front portion of the cartilege was frayed, and was removed. No ligatures were applied, but the synovial membrane and capsule were carefully closed by hæmostatic sutures of catgut. The tourniquet was not removed until a firm bandage had been applied. The leg was put up on a short straight back-splint for seven days.

2. Talipes Equinovarus due to Infantile Hemiplegia. *Time of operation*: 10.15 to 10.45.—Tenotomy and tendon transplantation. Tourniquet. Tendo Achillis divided by two lateral incisions 1 in. apart and one longitudinal incision joining the lateral; foot forced up into calcaneal position. The tendon of the tibialis anticus was transferred from the inner to the outer side of the foot by means of three incisions, the first exposing and dividing the insertion of the tendon, the second above the ankle serving to draw the tendon out, and the third over the base of the 5th metatarsal exposing the insertion of the peroneus brevis, to which the tibialis anticus was sewn. The foot was put up on a metal splint.

3. Deformity of Right Hand, Pronation and Flexion of Wrist, and Pointing of Right Foot, due to Infantile Hemiplegia. *Time of operation*: 10.50 to 11.10.—No tourniquet was used for the arm because of the danger of nerve injury. An incision 3 in. long over the postero-external aspect of the forearm, just behind the radial extensor

tendons. The latter turned forward, exposing the tendon of the pronator teres. This was divided and brought through a split in the radial extensor tendons, and there sewn with catgut. The tendo Achillis was lengthened as in the last case. In neither the hand nor the foot was the deformity over-corrected, because in these spastic cases there is always a danger of over-action by the opposite muscles.

4. Unilateral Congenital Dislocation of the Hip-joint in a Girl of 3 years and 9 months (*Fig.* 22). *Time of operation*: 11.20 to 11.45.—A small upright with a pelvic rest was clamped to the end of the table. The thigh was manipulated without any preliminary kneading of the adductors. Very quickly the head of the bone could be seen to jerk into its socket. The thigh was then brought down into abduction and

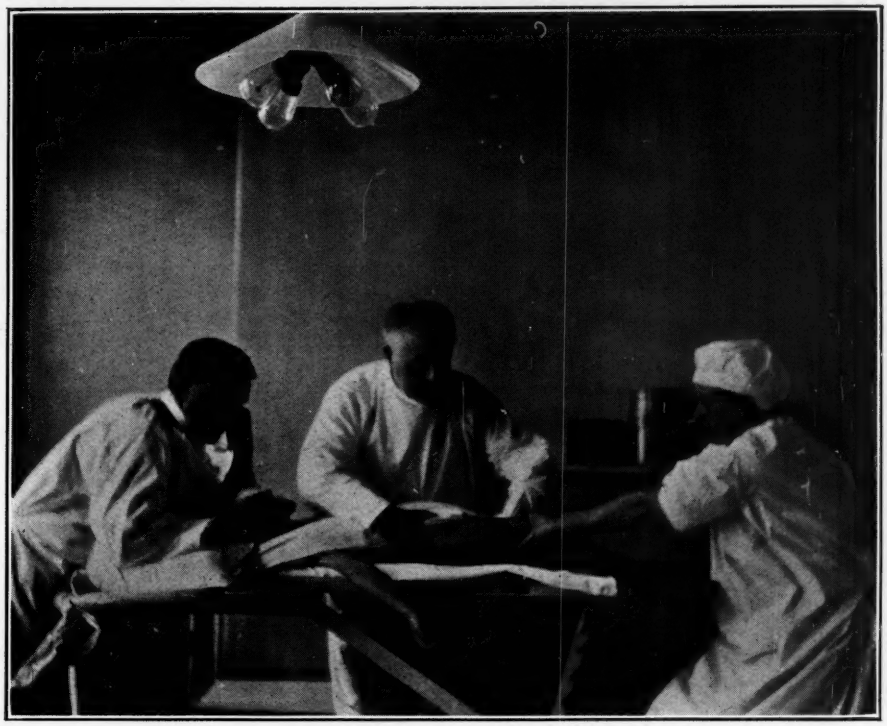

Fig. 22.—Reducing congenital dislocation of hip.

external rotation, and fixed by a plaster bandage. It is to be kept in plaster six months, being brought down to normal position in three stages. Sir Robert said that whilst at one time he had more than 50 per cent of relapses, this now was quite exceptional. He attributes the improvement to a shorter period of plaster fixation, and to greater attention to securing an anterior position for the head of the bone, with extreme external rotation, at the first sitting.

## THE CHILDREN'S HOSPITAL, HESWALL.

Under the influence of Sir Robert Jones, those responsible for the maintenance of the Children's Hospital in Liverpool have very wisely decided to found a large modern hospital right out in the country, where tuberculous and crippled children can get the best possible conditions of sunshine and fresh air. This hospital is at Heswall, on the estuary of the Dee, and the site is ideal for this purpose.

All the patients are in open-air wards day and night, and so rapidly do they derive

benefit from this that their greatest punishment is to be kept indoors for any length of time.

*Case* 1.—Poliomyelitis. Paralysis of Quadriceps. *Time of operation*: 3.25 to 3.40.—A tourniquet was applied. The biceps tendon was exposed by an external incision, and cut as low as possible. The patella was approached by a median incision, and the aponeurosis over it, and the superficial cartilage, tunnelled through from the mid-line to the outer edge. The end of the biceps tendon was drawn up into this tunnel and fixed there by catgut stitches.

*Case* 2.—Poliomyelitis. Talipes Valgus. *Time of operation*: 3.45 to 4.0.—The foot having been thoroughly wrenched, the peroneus longus tendon was exposed by two short incisions, the first over the cuboid bone and the second 3 in. above the ankle. The tendon was divided at the former, and then drawn up into the latter incision. On the inner side of the foot the insertion of the tibialis anticus was exposed, the long peroneal tendon brought through a split in it, and sewn there, after fully correcting the deformity.

*Case* 3. Genu Valgum. *Time of operation*: 4.15 to 4.25.—Through a small incision above the outer side of the knee, an Adams saw provided with a knob at the end was inserted after guiding with a director. The femur was cut half through and then broken. Incision closed by two stitches. Leg put up on a Thomas splint on which it was to be left for five weeks.

*Case* 4. Poliomyelitis. Extreme Talipes Equinus with Pes Cavus. *Time of operation*: 4.40 to 4.50.—The plantar fascia and the five extensor tendons were divided by subcutaneous tenotomies. The front of the foot was moulded by wrenching. The tendo Achillis was lengthened by a sliding tenotomy. Foot placed on a metal splint.

## THE SURGICAL AND ORTHOPÆDIC HOME, BASCHURCH.

More than fifty miles from Liverpool, in the heart of Shropshire, is one of the most remarkable hospitals we have ever seen. It is so peculiarly the outcome of Sir Robert Jones's enthusiasm and inspiration that we feel tempted to describe its genesis and history, but this might trespass too much on the space at our disposal.

Fig. 23.—Two convalescent cases at Baschurch.

In the year 1900 Miss Hunt, a lady living at Baschurch, who had been reclaimed from invalidism to activity by Sir Robert, began to collect crippled children, whom she conveyed once a week to Liverpool, that they might receive the benefit of his healing art. Very soon a country house was filled with these patients, and from time to time a shed or two were added—a simple operating-room (costing £120), a lean-to as a plaster-room, a gipsy caravan as a portable 'isolation ward', and other nondescript buildings, until at present there is a surgical unit of 200 beds, in which, as it has been said, "the curative value obtained per pound spent was greater than in any other institution in the world".

It certainly is a remarkable demonstration of the superiority of mind over matter, that in this curious jumble of shanties there is actually to be seen some of the finest possible surgical work in all stages of completion.

On the Sunday when we made our inspection, there was an attendance of about twenty medical men and women attracted by the special visit of Sir Robert Jones, who during the War has only been able to go there at rare intervals.

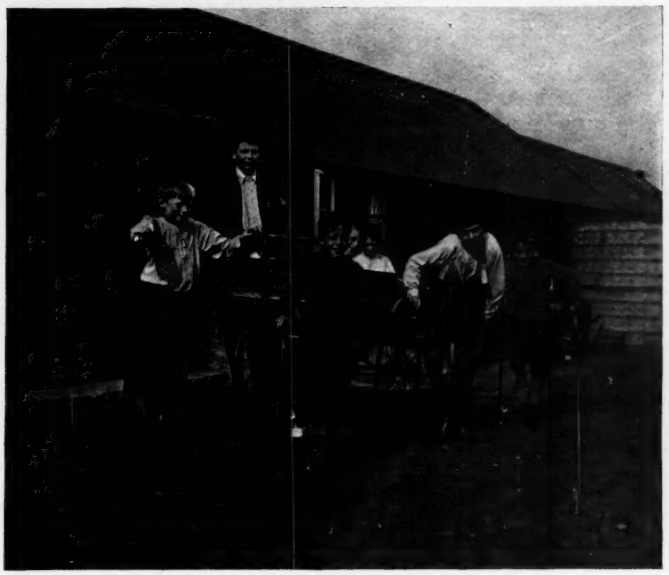

FIG. 24.—A group of patients.

In the first place, special cases sent for consultation were seen. These numbered seventeen, and presented all grades of difficulty, from a case of multiple spontaneous fractures associated with a doubtful malignant metastasis, and a case of rupture of the posterior crucial ligaments in both knee-joints, to those of the more ordinary gunshot injuries of the limbs, tuberculous spines, and deformed feet.

Not only was appropriate treatment suggested for each case, but where apparatus, e.g., splints or plaster, was required, this was to be made at the hospital by lady assistants and patients.

In the operating-room, primitive but efficient, the same care for aseptic precautions was observed as in the most ornate modern hospital.

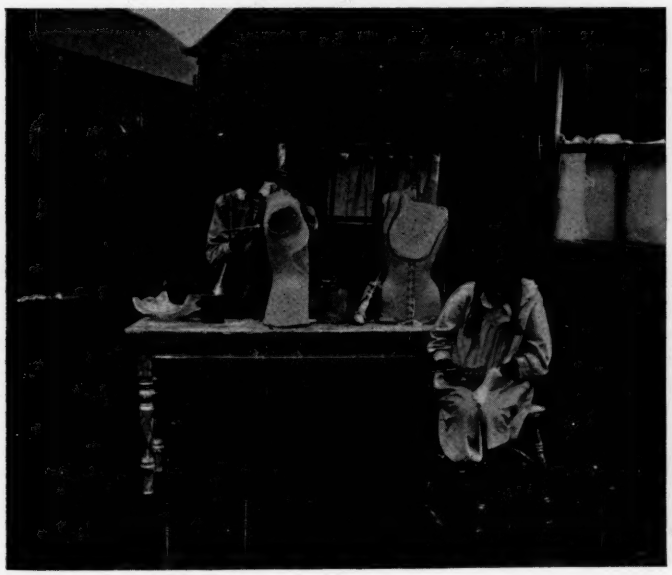

FIG. 25.—Splint-room—girls at work.

*Case* 1. TORN INTERNAL SEMILUNAR CARTILAGE. *Time of operation*: 2.10 to 2.25.—Tourniquet. Knee flexed over end of table; oblique incision; removal of frayed cartilage; suture of synovial membrane and capsule in separate layers. Skin sutured with silkworm gut; dressing applied with firm bandage; leg straightened; tourniquet removed. The operation was bloodless, and a perfectly clear field for observation provided.

*Case* 2. POTT'S DISEASE OF THE SPINE. *Time of operation*: 2.35 to 3.0.—Modified Hibbs's operation; an adult female with caries in the mid-dorsal region. A plaster case had been fitted to the trunk, made in an anterior and posterior portion; to the anterior case a metal frame supporting the forehead had been fixed, so that when the patient was

laid on her face and the back exposed, the head was held in position over the end of the table, conveniently for anæsthesia. A scab over the prominent vertebra was excised; an 8-in. incision exposed six dorsal spines, which were freed from muscle and ligaments;

FIG. 26.—Babies' sun-bath.

each spine was partly divided into three longitudinal pieces; the lateral pieces were turned alternately forward and backward so as to imbricate upon one another. The muscles

FIG. 27.—Open-air life.

were sewn over the spinous processes, the wound closed, and the posterior plaster case replaced.

Sir Robert Jones stated that this operation was only suitable for adults, and that in

such it gave a firm mass of bone, which served to immobilize the affected spine. He only does Albee's operation in exceptional cases, especially for very localized disease of the lumbar vertebræ.

*Case* 3. INFANTILE HEMIPLEGIA. *Time of operation*: 3.15 to 3.30.—Transplantation of the biceps tendon to the patella, to equalize the power of the extensors and flexors of the knee.

*Case* 4. ANKYLOSIS OF HIP FROM TUBERCLE IN A YOUNG ADULT. *Time of operation*: 3.40 to 3.50.—Tenotomies of the adductors and tensor fasciæ femoris; transtrochanteric osteotomy by Adams's saw passed across the trochanters parallel to Poupart's ligament. The bone was hard and difficult to divide; it was cut through partly, and then broken. Put up in an abduction frame.

*Case* 5. CONGENITAL TALIPES EQUINOVARUS. *Time of operation*: 4.0 to 4.10.—Wrenching, followed by plaster. Each element of the deformity was corrected as far as possible, first manually and then by Thomas's wrench, until the foot was flabby—almost flail. It was then put up in plaster in a fully-corrected position. In advanced cases where excision of bone or osteotomy has to be done, Jones condemns the practice of such bone operations until the maximum correction by wrenching has been carried out.

One of the special features of the work at Baschurch is that of the after-care of the cases at various village centres situated all over Shropshire. This is undertaken by trained lady assistants, who do their long rounds on motor-cycles, visit the patients, and fit splints and remove or re-apply plaster dressings.

The above description, which intentionally avoids either critical or laudatory comments, represents three days' work in Sir Robert Jones's clinic, and it filled the writer with great enthusiasm, which it is hoped he may have been able to convey to the reader in some measure by this simple word-picture.

# THE TREATMENT OF INOPERABLE CANCER WITH SELENIUM.[1]

By E. WATSON-WILLIAMS, Bristol.[18]

The attempt to eradicate malignant disease by injections into the blood-stream is of recent origin. The pathogenesis of cancer is as yet unknown; but it has long been our hope to discover some preparation that would cause the destruction of the proliferating cells, whether this proliferation be the entire morbid process or merely the manifest termination of other hypothetical local changes. It having been observed, however, that cancerous tissue possesses the property of concentrating in itself the mercury given for the treatment of syphilis, experiments were conducted to discover if other elements might not likewise be selected with this object in view: for it appeared possible that, if it were so, a protoplasmic poison might be given in doses which, though small enough not to injure the patient, might yet become sufficiently concentrated in the cancerous cells to effect their destruction. It was found that a large number of elements, chiefly metals and metalloids, show this affinity in greater or less degree; of these, copper is the best known in this country.

In 1911, Wassermann, working with carcinomatous mice, found that injection of a solution of selenium-eosin produced remarkable changes in the tumour.[17] Frequently, severe hæmorrhage occurred into it; with or without this phenomenon—a common feature in radium treatment in mice—many of the tumours were absorbed more or less completely: it appeared that a cure for cancer was available. The discovery naturally aroused great interest; the intensely poisonous nature of the medicament, however, rendered its direct application to human patients too hazardous. The difficulty was surmounted by the preparation[9,13] of a colloidal suspension of selenium. Briefly, this is a suspension of ultramicroscopic particles, of a size comparable with those of the largest molecules, in a very dilute solution. Such a fluid does not give the chemical reactions characteristic of a solution, since these depend on the presence of ions of the substance dissolved, which do not, for practical purposes, exist in the suspension. A commercial preparation was shortly available, and its toxicity having been shown by animal experiments[3] to be negligible, the way was open for therapeutic application of the remedy.

Selenium is a somewhat rare non-metallic element of atomic weight 79·1, resembling sulphur in general chemical properties. It was discovered in 1817 by Berzelius in the refuse of a sulphuric acid works. It is widely distributed in nature as an impurity of sulphides of various metals and otherwise. Of the element, five allotropic forms are described, of which two are red and three black. Only one is of importance in the present description, the brick-red selenium-β. It was first used medicinally for cancer by Stapf in 1833, and has subsequently appeared in various powders and pastes employed by the profession, and also by commercial enterprises, for the relief of malignant ulcers. The intensely poisonous nature of all its soluble compounds was inimical to its success, and interest in this element has been practically confined to the curious photo-electric properties of the 'black metallic' allotrope.

**Preparations of Selenium.**—Following the experiments of Wassermann, Comar et Cie, of Paris, produced a colloidal suspension of selenium. This is a coral-red fluid, 'electroselenium', and is stated to be electrically-prepared colloidal selenium-β. The strength is 1–5000 of the element; the particles are said to be of the diameter of 5 to 20 $\mu\mu$; this probably refers to the approximate size of the smallest particles. It is isotonized by the addition of sodium chloride, and sterilized. This preparation will be referred to as Se C. No attempt appears to have been made to 'protect' the suspension colloid by

the addition of emulsion colloid. Perhaps the early depression phase of the general reaction reported by those who used it is partly attributable to this ; one would certainly expect some shock after intravenous injection of unprotected suspension colloid.

A fluid chemically prepared by Messrs. Crookes (Se O) was available in England, and was used in the earlier cases tabulated below. This was of a strength of 1–1000, and isotonized with sodium chloride. A method of preparation is given in the *Extra Pharmacopœia*.[11] It was found, however, not to be satisfactory : in particular, the precipitation which one would have expected, frequently occurred. Messrs. Crookes therefore evolved a more suitable injection, 'collosol selenium' (Se N), with which the bulk of these observations have been made. This is a dichroic coral-red fluid consisting of a sterile 1–2000 chemically-prepared colloidal suspension of selenium-β, protected by the presence of suitable emulsion colloid (peptone), and isotonized with glucose. The 'intravenous' preparation contains particles up to a slarge as 500 $\mu\mu$ ; the 'intramuscular' contains even larger particles, up to 800 $\mu\mu$ approximately : there appears to be no other difference. The liquids have proved very stable. The series quoted below is too short for accurate comparison, and only a few cases had more than one preparation ; but that last described appeared to be the most active, and has never given rise to those symptoms of shock which were not uncommon after the intravenous injection of some of the other preparations.

Martindale's preparation (Se S) was Crookes' 1–1000 diluted to 1–5000 and isotonized at the time of injection.

A few experiments have been conducted with an allotropic modification, selenium-α ; but this appears to be inactive.[19]

**Technique.**—The suspension may be given by intravenous or intramuscular injection. Injected subcutaneously or into intermuscular areolar tissue, it causes pain and is not well absorbed. Intramuscular injection is not very painful, and the clinical results appear the same as by the intravenous route. Injection into the gluteus, or in a bed-ridden patient into the deltoid, appears to be best : a limit of about 5 c.c. has necessarily to be placed on the dose by this route. It is, however, useful to avoid a marked reaction in feeble patients, or where, in the debilitated, the veins are difficult to inject.

The intravenous route is to be preferred. Either 'intramuscular' or 'intravenous' suspension may be given. The general reaction is never alarming, and only very occasionally noteworthy. The focal reaction is more abrupt in onset and somewhat more intense. As much as 20 c.c. daily has been given by this route with no ill effects. The quantity of emulsion colloid present is so small that no serum change appears to occur ; the suspension colloid would presumably not give rise to one in any case. Many of the injections have been given in the out-patient department, and the patients allowed to go home half an hour later. No special precautions appear to be necessary ; if, however, a leak into the subcutaneous tissues occurs, a fomentation helps to minimize the local irritation. The same vein may be used day after day.

Although the cases tabulated show a wide variation in periodicity and size of dose, an attempt has been made to adhere to the following scheme :—

A dose of 5 c.c. on the 1st and 3rd day, followed by 10 c.c. on the 5th, 8th, 10th, and 12th days ; then a month's rest, to be followed by 10 c.c. twice a week, until a total of 100 c.c. have been administered in all.

In the presence of a large growth, smaller doses are given ; for a small one, or after extirpation of the bulk of the tissue, daily doses of 10 c.c. or more may be used. One is, of course, prepared to diminish or stop the administration in the event of much disturbance, or other evidence of intolerance. The dosage recommended above has never given cause for the least anxiety. Injections of 10 c.c. once a week can also be used if more convenient ; the total dose required is about the same. Two cases developed intolerance, as evidenced by myalgic pains and hæmaturia, in the course of prolonged administration : two showed some intolerance almost from the start. The symptoms disappeared entirely on stopping administration. Later courses have been used in a few cases : the data are not sufficient for a pronouncement on their value.

**Effects of Treatment.**—The immediate effects following on a single injection fall into four groups. Within a few minutes, with one preparation—'electroselenium'—a mild degree of shock is occasionally noticeable. There is a rigor sometimes, more commonly some collapse, with thready pulse, low temperature, and a feeling of nausea and faintness. This passes off in from ten to forty minutes. It has not been observed after intramuscular injections.

A reaction is usually noticed by the patient first in the growth itself, especially where this is in a sensitive situation such as the tongue or larynx. The part feels hot, heavy, and stiff. A definite focal reaction can be observed shortly after, usually in four to six hours from the injection. Slight tumescence of the growth from increased blood-supply is apparently the cause, probably arising from irritation by the local deposition of selenium. Some œdema also occurs, and is less transitory. The effects are not very marked objectively; in discharging growths the discharge may be temporarily increased.

Following shortly upon this the general reaction, properly so-called, takes place. A rise of temperature to 100° or 101°, rarely more, with some headache and malaise, is fairly common. It is held to be due to absorption into the circulation of material destroyed by the drug. It occurs from six to ten hours after injection, and lasts about the same period. For equal doses the subjects of large tumours suffer a more considerable reaction;[2] this observation supports the suggested theory of causation. This reaction is less marked after later doses than after the earlier, and is not observed at all in many cases. The focal and general reactions have been taken as an indication of the clinical activity of the preparation given.

Twenty-four hours after administration other than intravenous, a local reaction is seen at the site of injection. Some redness, swelling, and stiffness are the only symptoms noted. They subside without causing trouble: no case of abscess formation or similar complication has been recorded.

Of the fate of the drug after injection, little is known. Experimental evidence regarding its fixation in the malignant tissue, its effect on excretions, etc., and its own excretion, is referred to below.

The effects following a course of injections are usually well marked. They are gradual in their appearance, and the improvement continues for some time after the injections have ceased.[18] (1) The first effect is noticed by the patient, and is a local one: Diminution or disappearance of pain. In a favourable case there follow: (2) Diminution in tenderness; (3) Cleansing of ulcerated surfaces, decrease of discharge, granulation; (4) Diminution in size and hardness of the tumour and secondary deposits; (5) Increased mobility of the part. In the general condition one may note: (6) Improvement in anæmia and cachexia; (7) Improved sleep and memory; (8) Increase in weight and strength; (9) Marked psychic improvement: this is due partly, no doubt, to the feeling that something is being done, but is also largely attributable to relief from pain, sleeplessness, and the intolerable discomfort of fœtid discharges.

All these results do not follow in every case, nor is the improvement always permanent. Some, however, of the patients treated were in such a condition as to preclude this hope; but nearly all experienced considerable benefit. Broadly speaking, those patients with growths in vascular areas such as the alimentary tract, bladder, or uterus respond best to treatment; those with mammary, laryngeal, tonsillar, recurrent, or very rapidly growing tumours derive less benefit, as also do very aged or debilitated patients. In a few cases the formation of a firm cicatrix has, by its interference with function, somewhat marred the result from a clinical point of view. But when destruction of tissue has occurred, a cicatrix is the best that can be expected, and in any event is almost certainly preferable to a malignant ulcer.

**Indications for Treatment.**—The treatment appears to be suitable for two classes of patient. In inoperable cases, the results obtained compare favourably with any known method of attacking the growth by the blood-stream, and are approximately equal to those of radiotherapy. The moderate focal reaction is in no way comparable to the local reaction from radium: the preparation appears to be considerably more active than

copper given as cuprase or copper alanin. All malignant tissue is affected, however inaccessible. As a purely palliative treatment, the drying of ulcers and abolition of pain is a marked advantage. The injections have the minor advantage of low cost.

As an adjunct to operative measures, including diathermy, the treatment may be applied to a variety of conditions. Where operative removal has not been as free as desirable, the possible outlying cells might be destroyed by injections. In patients having a course of injections, wounds in carcinomatous tissue have been observed to heal. Cases pronounced inoperable may give hope of becoming operable when sepsis and fixation have been diminished by this treatment. Possibly malignant processes might be held in check for a few weeks in patients who cannot arrange to submit to an operation at short notice: time is necessary before deciding as to the value of selenium in such cases.

**Contra-indications.**—There appear to be no positive contra-indications to this preparation. Caution is, of course, desirable in cases of carcinoma of the larynx, secondary mediastinal deposits, or other conditions in which tumescence of the morbid tissue might cause embarrassment. With 'electroselenium' especially there appears to be a tendency for glands to undergo aseptic colliquefactive degeneration; it is doubtful, however, whether this is entirely to be attributed to the drug, and in any event it is not a troublesome feature.

**Results of Treatment.**—Before leaving the subject of treatment, it will be convenient to give a few notes of the results already achieved with this preparation. The cases it has been found possible to collect are briefly analyzed in the following table. Nearly all the investigators used 'electroselenium,' and injections were made by a variety of routes—subcutaneous, intramuscular, intravenous, and into or near the tumour.

*Table I.*—Analysis of Cases.

| Investigator | Number of Cases | Injections | | | | | Improvement | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Average dose in c.c. | Average number | Interval in days | Average total dose, c.c. | Largest total dose in one case in c.c. | Considerable | Appreciable | None |
| Cade and Girard [4] .. | 8 | 5 | 15 | 3 | 75 | 100 | 2 | 3 | 3 |
| Bougeant and Galliot [3] | 12 | 5 | 20 | 2 | 100 | 250 | 12 | — | — |
| Blumenthal [2] .. .. | 6 | — | — | — | — | — | 2 | 4 | — |
| Trinkler [16] .. .. | 4 | 5 | 9 | 2 | 45 | 55 | 4 | — | — |
| Touche [15] .. .. | 27 | 5 | 5 | 7 | 25 | 130 | 9 | 11 | 7 |
| Hope [10] .. .. .. | 2 | 5 | 3 | 7 | 15 | 15 | 2 | — | — |
| Carles and Vieron [5] .. | 10 | 3 | 20 | 3 | 60 | 100 | 6 | — | 4 |
| Conseil [6] .. .. .. | 5 | 5 | — | — | — | — | 3 | — | 2 |
| Others .. .. .. | 16 | — | — | — | — | — | 13 | 1 | 2 |
| Totals .. .. .. | 90 | | | | | | 72 | | 18 |

Lidy reports a number of cases, but details are not available.

*Table I* shows that about four in five of the cases benefited. Eight are reported as apparently complete cures clinically.

The general effect of the administration of selenium as reported by these investigators is substantially in agreement with that found in the cases reported below. They observed on the whole a more considerable general reaction, but make little mention of any focal reaction, that is, immediate change in the morbid tissue. It seems not entirely probable that the large constant general reaction was due to a more active preparation, as in my

series it was found that the 'collosol selenium' appeared considerably more active than 'electroselenium'. These and other observers have, however, elicited a number of facts which throw light on the mode of action of the element; as it is exceedingly difficult to detect it with certainty in very small amounts, it has not been practicable to repeat their observations.

**Mode of Action.**—Given in relatively enormous doses to animals,[8] the element was found to remain, after all excretion ceased, in certain tissues. In the first place, it was not found possible to kill rabbits by daily injections for 60 days, although a single injection containing the same dose and concentration of selenious acid produced death in a week. On killing the animals and analyzing the organs, selenium was found in the liver and the blood. Traces were also observed in the bones, lungs, heart, suprarenals, and testes. Congestion of the kidneys was also observed: the other tissues were histologically normal. Observation on human subjects, who had been given relatively very much smaller doses, showed that the element can be recovered in quantity from the cancerous tissue[7,12]. The urine of cancer patients increased in toxicity after injection; that of healthy controls did not.[5] A marked leucocytosis followed the injections; there was also a rise of temperature,[2] again peculiar to cancer patients, and roughly proportional to the size of the tumour for similar doses of the drug. These facts support the view of a flooding of the circulation with the products of autolysis of cancer cells to which the action of the drug has been ascribed. The cancerous tissues affected by the drug showed nucleolysis[12] and minute areas of hæmorrhage. The drug is excreted in the urine;[8] its effect on the solid constituents of the urine is in dispute.[4] Prolonged administration may give rise to a transient albuminuria. Colloidal selenium has no effect on ordinary pathogenic bacteria *in vitro*:[11] this does not preclude the possibility of a germicidal effect *in vivo*. Dead cancerous tissue shows no affinity for the element.[14]

From these observations it is possible to deduce a theory of action of the drug. It would seem that cancer tissue, by reason of some peculiarity in itself, has a special affinity for it. In any appreciable concentration it probably acts as a protoplasmic poison, causing destruction of the cells or their nuclei (or even, if these exist, of the parasites contained in them). It is of course possible that it exercises a merely germicidal action, and that the good clinical results are due to this. It is true that a number of patients did not continue the initial improvement, even on increased doses. In several cases, however, definite arrest of the malignant processes appears to have occurred. Relatively very small doses of the element could be given; and it is possible that if one could give much heavier doses the improvement would be more constant and permanent. Attempts are believed to have been in progress in Berlin during the last five years to produce an organic compound analogous to salvarsan: no reports, however, as to the results obtained are yet available.

## SUMMARY.

Whatever theory of the causation of malignant disease proves to be correct, and whatever the mode of action of a particular remedy in any case, the value of the treatment must depend on the results obtained, not in the laboratory, but with patients.

*Table II* shows the dosage and results in twenty cases.

The remaining cases received a few injections only. Neglecting *Cases* 15 and 18, in which radium was used in conjunction, there remain 18 cases. Apparent arrest of the malignant process was observed in 6 of these; diminution could be inferred from observation in 5 more; the condition of the remainder was inconclusive. Two cases showed apparent complete relief of their symptoms; 5 were relieved of all or nearly all their symptoms, and so remained through the period of observation; 7 more experienced considerable relief for a longer or shorter period. That is, apparent arrest, and relief of symptoms, followed treatment in one case out of three; and in the whole series the majority experienced a considerable benefit. The series is of course a very small one from which to draw conclusions, and the period of observation is too short for the formation of pronounced views. The hopes that the almost universal early improvement inspired

have unhappily not been fulfilled, and it is to be feared that the proportion of apparently successful results will be reduced as the period of observation lengthens.

Nevertheless, from these instances one may justly conclude that the injection of colloidal selenium has established a definite claim for consideration in certain cases as a therapeutic measure :—

1. In a class of patients whose outlook has till recently been almost hopeless, a very considerable degree of benefit may be expected.
2. Pain, sleeplessness, ulceration, and discharge are markedly diminished.
3. In favourable cases a fair degree of comfort is attained (several returned to work).
4. In a few cases the degree of relief comes within measurable distance of a 'cure'.

*Table II.*—Dosage and Results in Twenty Cases.

| No. | Site of Tumour | Injections | | | | | | | Period of Observation in Months | Result | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Route | Preparation | Average dose in c.c. | Number of doses | Average interval in days | Total dose in c.c. | Total dose in mgrm. | | Arrest of malignant process | General and local relief |
| 1 | Pylorus | M | O | 3½ | 15 | 3 | 50 | 50 | 4 | — | T R |
| 2 | Colon | M | N | 5 | 2 | 3½ | 10 | — | — | — | — |
| | | V | N | 5 | 4 | 3½ | 20 | 15 | 4 | ? | I |
| 3 | Breast | M | N | 5 | 14 | 3½ | 70 | 35 | 3 | — | T I |
| 4 | Breast | M | N | 5 | 10 | 3½ | 50 | 25 | 4 | ? | R |
| 5 | Stomach | M | O | 3½ | 2 | 2 | 7 | — | — | — | — |
| | | V | N | 5 | 15 | 5 | 75 | 44 | 7 | A | Cd. |
| 6 | Cheek | M | O | 3 | 7 | 2 | 20 | — | — | — | — |
| | | M | N | 5 | 9 | 3½ | 45 | 42 | 4 | T | T R |
| 7 | Uterus | V | N | 8 | 6 | 2 | 50 | 25 | 1½ | A | R |
| 8 | Uterus | V | C | 7 | 7 | 3½ | 50 | 20 | 2 | None | ? |
| 9 | Uterus | V | N | 5 | 4 | 3½ | 20 | — | — | — | — |
| | | M | N | 10 | 3 | 3½ | 30 | 25 | 2 | A | R |
| 10 | Bladder | V | N | 7 | 12 | 3½ | 82 | 41 | 4 | A | R |
| 11 | Parotid | V | N | 12 | 8 | 2 | 95 | 47 | 2 | — | Neg. |
| 12 | Tongue | V | N | 9 | 11 | 2 | 105 | 52 | 8 | T | T R |
| 13 | Tonsil | M | N | 5 | 10 | 1 | 50 | — | — | — | — |
| | | V | N | 14 | 6 | 3 | 80 | — | — | — | — |
| | 2nd course | V | N | 10 | 4 | 7 | 40 | 85 | 5 | A | R |
| 14 | Tonsil | M | N | 5 | 6 | 2 | 30 | — | — | — | — |
| | | V | N | 11 | 6 | 3½ | 63 | — | — | T | — |
| | 2nd course | V | C | 10 | 2 | 7 | 20 | 50 | 6 | — | T R |
| 15 | Tonsil* | V | N | 9 | 7 | 1½ | 65 | 32 | 1 | — | Neg. |
| 16 | Larynx | V | C | 8 | 8 | 2 | 60 | — | — | T | — |
| | 2nd course | V | N | 10 | 7 | 2 | 70 | 47 | 5 | — | T R |
| 17 | Larynx | M | S | 4 | 9 | 2 | 35 | — | — | — | — |
| | | V | N | 10 | 6 | 3 | 57 | 35 | 6 | T | T R |
| 18 | Larynx* | M | S | 3½ | 8 | 1 | 30 | — | — | — | — |
| | | V | N | 8 | 6 | 3 | 50 | — | — | — | — |
| | | V | N | 10 | 5 | 3½ | 50 | 55 | 5 | A | I |
| 19 | Larynx | V | S | 4 | 7 | 1 | 25 | — | — | — | — |
| | | V | C | 5 | 1 | — | 5 | — | — | — | — |
| | | V | N | 10 | 18 | 5 | 170 | 91 | 6 | T | T R |
| 20 | Œsophagus | M | N | 5 | 8 | 2 | 40 | — | — | — | — |
| | | V | N | 15 | 6 | 3½ | 87 | 63 | 7 | A | Cd. |

M. Intramuscular; V. Intravenous; N. 'Collosol' selenium; O. C. S. Other preparations (see text); A. Apparent arrest of malignant process; T. Temporary; R. Relieved of symptoms; I, Improved; Cd. Apparently cured; Neg. Not appreciable.
* Radium used in conjunction.

Complete reports of a few cases are appended. The remainder, and acknowledgement of my great indebtedness to a number of surgeons, are published in the original thesis.[1]

## SELECTED CASES FROM *Table II.*

*Case* 5.—**Carcinoma of great curvature of stomach.** Female, 37. Nurse.

HISTORY.—Vomiting blood. One year's history. Dyspepsia a year ago, with melæna; subsided on resting. Recurred a month ago and became worse. While in bed she felt suddenly sick and faint, and vomited about a pint of blood.

ON EXAMINATION.—Epigastrium is tender, nothing felt.

Laparotomy: A large nodular carcinomatous mass in posterior wall of greater curvature of the stomach, binding it to the abdominal wall. Possibly an adherent carcinoma of the pancreas. A crateriform ulcer one and a half inches across was felt in the posterior wall of the stomach through the anterior wall. Secondary nodules in the liver.

Since the hæmatemesis pain has been constant and severe. On a fluid diet it is continuous and prevents sleep. There has been marked anæmia and wasting. No further melæna noticed. Vomiting, but not of blood, after most feeds. The laparotomy was undertaken as an emergency, as she had had no sleep for three nights in spite of large doses of morphia, and was becoming exhausted.

The day after the laparotomy 2 c.c. selenium O were given intramuscularly, followed by a dose of 5 c.c. The patient said she felt better. Five c.c. selenium N were given intravenously twice a week for five doses, then once a week for other ten doses. The pain after meals disappeared, and the patient returned to a general diet, avoiding butcher's meat and roots only. Sleep soon became normal, morphia being discontinued after the second dose. Some œdema of one foot appeared, doubtless from swelling of secondaries, but soon subsided. She put on flesh and began to get about. Intolerance, evidenced by myalgia and malaise after injection, appeared, and the injections were stopped. The patient, a nurse, thinks that her convalescence from 'gastro-enterostomy' was rather slow (the operation, of course, had not been performed); but proposes to return to work soon, apparently cured.

Total dose, selenium O 7 c.c., selenium N 75 c.c. = 82 c.c. Observation seven months. Apparent cure.

*Case* 9.—**Carcinoma of the cervix uteri.** Female, 53. Housewife.

HISTORY.—Blood-stained and, later, fœtid vaginal discharge; three months' history.

ON EXAMINATION.—A mass can be seen and felt in the vagina, replacing the cervix. It is nodular, friable, and in the centre deeply ulcerated. The wall of the bladder, the uterosacral ligaments, and the right broad ligament are extensively involved. There is a constant burning pain in the vagina; gentle examination is painless. A profuse stinking yellow discharge is present. Constipation has recently appeared, with frequent and painful micturition. She has lost a lot of of flesh recently. The appetite is poor; sleep fair; complexion pallid, but not cachectic.

Under ether, the uterus was curetted. The pathologist reports 'epithelial carcinomatous masses'. The uterus was packed with formalin. Five days later pain was worse, and in lower abdomen. The fœtid discharge was as before; an extension of the growth on the vaginal fornix was observed.

Four intravenous injections of 5 c.c. selenium N were given, followed by three intramuscular of 10 c.c., two a week. No marked general reaction was observed, except a rise of temperature to 100° after the sixth, with malaise and headache. No focal reaction was noted. There was some tenderness and stiffness at the site of the intramuscular injections. The fœtor and pain diminished rapidly. The discharge completely dried up after the last injection. Constipation was unchanged, but micturition became normal. Weight remained stationary.

Total dose, selenium N 50 c.c. Observation two months. Relieved.

*Case* 10.—**Carcinoma of bladder.** Female, 56. Housewife.

HISTORY.—Inability to retain urine and fæces, pain in urethra, and wasting. Eight months' history.

ON EXAMINATION.—A large mass is felt per vaginam deep to the anterior wall of the vagina and attached to it. The uterus is small and mobile. The mass is hard, irregular, and surrounds the neck of the urethra; it is tender. Per rectum the same. Cystoscopy: nothing valuable could be seen owing to the presence of blood. Hard glands in both groins, with acute pain and attacks of retention. There is abdominal pain fairly constantly. Recently incontinence of urine (with empty bladder) and of fæces has been troublesome. Loss of weight, appetite, and sleep marked; anæmia and lassitude noticeable. The patient was in a miserable condition, constantly soaked in urine, less constantly soiled with fæces. The urine contained a great deal of blood and pus. Morphia in increasing doses was required nightly.

Three doses of 2½ c.c. selenium N were given intravenously, followed by three of 5 c.c. and six of 10 c.c., two a week. Morphia was discontinued after the second dose. No general reaction, except after the first dose, and no focal reaction, were observed. Incontinence ceased after the fourth dose. Hæmaturia, pain, and tenderness—even on catheterization—disappeared after the sixth. The growth appeared softer, but same size; the glands in the groin were considerably smaller. Two months later the patient was up and about, though still feeble. She required a catheter, but there was no pain or difficulty in using it. She had ceased to lose weight. The

anæmia was less, and her general condition enormously bettered. There had been no further hæmaturia; the patient had not again required morphia.

Total dose, selenium N 82·5 c.c. Observation four months. Apparently an arrest of malignant process.

*Case* 16.—**Carcinoma of larynx.** Male, 50. Gardener.

HISTORY.—Pain in throat and roof of mouth, intermittent, and worse on swallowing. Six months' history. There has been one hæmorrhage from throat, but no other symptoms at all, except recently loss of sleep, and some hoarseness.

ON EXAMINATION.—The right aryteno-epiglottidean fold is ulcerated away, being replaced by a nodular mass, which obscures the anterior end of the larynx. The epiglottis and neighbouring structures are swollen. Some glandular enlargement. Weight, appetite, sleep, and memory normal.

Selenium C was given in four doses of 5 c.c. on alternate days, then four of 10 c.c. A general reaction—shivering, malaise, headache, and giddiness—followed soon after each injection; a focal reaction was noticed about four to six hours after. The pain and sleeplessness disappeared, and patient resumed work. Two months later he returned with very fœtid breath and a cystic gland. Ulceration had recurred, and the laryngeal tumour was larger. The gland was incised, and 3 oz. glairy fluid evacuated. The wound healed by first intention. Fluid subsequently collected, and was withdrawn on several occasions. Selenium N, 10 c.c., was given on alternate days up to 70 c.c. After the fifth dose he "had the first uninterrupted night for five weeks". A vigorous focal but no general reaction followed each injection. He was conscious of a great feeling of relief as the reaction subsided. The difficulty in swallowing persisted, though pain vanished. The malignant process appeared to be steady, but much slower than before the injections.

Total dose of selenium C, 60 c.c., selenium N, 70 c.c. Observation six months. Temporary relief. The patient died suddenly from hæmorrhage a short time ago.

*Case* 19.—**Carcinoma of larynx.** Male, 69. Labourer.

HISTORY.—Hoarseness of six weeks' duration, and pain on swallowing. Sleep poor, nutrition fair.

ON EXAMINATION.—An extensive cauliflower growth involved the right aryteno-epiglottidean fold, from epiglottis to cricoid. The growth was not ulcerated. Pathological report, 'carcinoma'. A large gland, not tender, was found on right side of thyroid.

Selenium S, 2·5 c.c., was given daily for four days intravenously, followed by 5 c.c. doses for three days. The pain was a little improved, but no other change was noticed. One dose of 5 c.c. selenium N was given, followed by eighteen of 10 c.c., at first every third day, later once a week. One dose of selenium C was given. No general reaction occurred, but a focal reaction was noticed after every dose but the first. The pain completely disappeared with the second dose, the growth shrank enough for the vocal cord to be seen, the voice became almost normal; the gland became smaller. Sleep improved. The weight increased 6 pounds. About half-way through the course the growth had ceased to be nodular and showed as a cherry-like smooth mass in the fold, half appearing medial and half lateral to it.

Later, the surface ulcerated, and sepsis became very troublesome. Bronchitis and dysphagia followed. Six months from the beginning of treatment, laryngeal œdema necessitated tracheotomy; the patient died of bronchopneumonia shortly after.

Total dose, selenium S, 25 c.c., selenium C, 5 c.c., selenium N, 170 c.c. Observation six months. Temporarily relieved.

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# ON THE OCCURRENCE OF MASSIVE CHOLESTERIN DEPOSITS IN THE BREAST IN CASES OF LONG-STANDING MASTITIS.

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Cholesterin in crystalline form may be deposited in the tissues in many situations and as a result of divers pathological processes. In most cases the crystals make their appearance in consequence of local tissue disintegration, whether from necrosis or from the retention of inflammatory exudates or effused blood. In certain situations, such as the breast, an additional possible factor is the retention of secretory products which results from duct obstruction.

The tabular form of cholesterin is most frequently met with, giving rise to the well-known appearance of clefts in paraffin sections; less often the acicular crystalline form is assumed. When the crystals are deposited in, or come to be surrounded by, living connective tissue, they stimulate the formation of a very special cellular reaction round about, in which foreign-body giant cells and endothelial cells with foamy cytoplasm form the most prominent feature.

In the breast, certain forms of subacute inflammation with retention of the secretions have been found to be associated with the deposition of cholesterin crystals, mainly of the acicular type. These occur within the lumen of the inflamed and dilated ducts, and when once the epithelial lining has been shed, they become surrounded by a complete ring of foreign-body giant cells, from which fine cytoplasmic processes run inwards between the individual crystals. These giant-cell rosettes are highly characteristic structures as seen in paraffin sections, and may be present in quite considerable numbers. In a few instances plate cholesterin has also been demonstrated amongst the inflammatory tissue.

The total amount of cholesterin present in the breast in such circumstances is usually quite small, but, exceptionally, very large quantities may be deposited. The writers have had the opportunity of studying two such cases, the details of which follow:—

*Case* 1.—(1903.)

Clinical History.—The patient, a woman, age 63, gave the following history. She was married in 1860 at the age of 19, and her first child was born ten months later. Her second and only other child was born nine years after the first. In the interval she had a miscarriage, and she also had an abscess of the left breast, which, however, had quite recovered by the time the second child was born. Both her children were suckled on both breasts. In 1893, ten years before admission to hospital, she received a blow on the left breast. Thereafter, a small, hard lump made its appearance in the breast and slowly increased in size, while latterly the nipple discharged blood and 'matter' from time to time. Towards the end of 1902 there was a rapid increase in the size of the tumour, which became also less mobile and very painful, while the skin over it became inflamed.

On Admission to hospital on January 10, 1903, the breast was very much enlarged and inflamed. Parts of the tumour were hard and nodular, but in the centre near the nipple it was soft and fluctuating. The skin here was stretched and shining, and of a dark-purple colour, and on the day following admission it ruptured, allowing the escape of a large quantity of glistening, blood-stained serous fluid. There still remained within the cavity a soft, jelly-like, semifluctuant material, which gradually disappeared in the course of the day, leaving the cavity lined by what were thought to be sprouting granulations. No enlarged glands could be felt in the axilla. The breast was amputated one month later.

DESCRIPTION OF SPECIMEN (*Fig.* 28).—The breast contains a number of cysts measuring from ¼ in. to 2 in. in diameter, with thick fibrous walls. Two of the largest communicate by wide apertures with the surface. The cysts in every instance show a number of white, cauliflower-like nodules of tumour-tissue sprouting from their walls, and in three the entire space is occupied by these masses of growth. Otherwise the cyst walls are perfectly smooth inside, and on transverse section they show a narrow inner layer of white fibrous tissue, and an outer broader zone of a rich-brown colour, due to the presence of iron-containing pigment. Immediately adjacent to some of the cysts there are circumscribed solid areas, showing a mixture of the same rich-red tissue with yellowish, glistening patches of cholesterin and lipoid deposit.

FIG. 28.—*Case* 1. Slice from the centre of the breast, showing cysts with papilliferous carcinomatous masses sprouting from the walls. The cholesterin-bearing portions are the solid dark areas adjacent to the cysts.

The whole breast lesion is sharply defined at the margin, being apparently encapsuled by fibrous tissue. The nipple is retracted, owing to involvement of the deeper parts of the galactophorous ducts.

HISTOLOGY.—The solid white masses which project into all the cysts are composed of active, cellular, adeno-papillomatous tissue, with abundant evidence of malignancy in the form of solid, spheroidal-celled carcinomatous areas here and there. The histology of the cholesterin-containing areas will be described in conjunction with those of *Case* 2.

AFTER-HISTORY.—The patient, now in her 80th year, was visited a few weeks ago, seventeen years after the operation. She was found to be in good health, with a well-healed linear scar over the left side of the chest.

*Case* 2.—(1903.)

CLINICAL HISTORY.—The patient was a married woman, age 60, who had borne no children. She first began to have pain in the left breast at the age of 34, and this, together with an intermittent serous or blood-stained discharge from the nipple, continued for about seven years. The discharge then ceased, and for the ensuing nineteen or twenty years there was a slowly progressive enlargement of the affected organ. During this time the general health remained good; but in the summer of 1903 she began to be alarmed lest she might be suffering from cancer, and in consequence became worried and ill. She finally consulted her doctor in November of the same year, and a diagnosis of cystic tumour, probably non-malignant, was made. The breast was amputated on November 7, 1903, and she made an excellent recovery.

FIG. 29.—*Case* 2. Two large thick-walled cysts are seen, with one smaller one between. The speckling of the interior of the cysts is due to deposits of cholesterin.

DESCRIPTION OF SPECIMEN (*Fig.* 29).—The breast is very greatly enlarged, and is occupied by two large cysts with an intervening small one. These measure roughly 6 in. × 6 in., 4 in. × 2 in., and 1¼ in. × ½ in. Each cyst presents a rough lining, and the largest shows a number of slightly raised, glistening white nodules of cholesterin deposit. The cyst walls are much thickened, of a dark-brown colour, and speckled all over the cut surface with small glistening deposits of cholesterin crystals. There are no papillomatous in-growths like those seen in *Case* 1, and no normal breast tissue can be determined. The skin of the breast is stretched out over the cysts, and the nipple is flattened out rather than retracted.

HISTOLOGY.—The microscopic structure of the walls of the cysts is very similar to that of the brown, cholesterin-containing areas in *Case* 1, and the same description will serve for both.

AFTER-HISTORY.—The patient is now 76 years old, and in good health. There is a linear cicatrix at the site of the old operation.

## MICROSCOPIC STRUCTURE OF THE CHOLESTERIN-BEARING AREAS.

In paraffin sections the salient feature of the microscopic structure of these areas is the enormous aggregation of 'cholesterin clefts'—that is, spaces from which tabular crystals of cholesterin have been dissolved out in the process of paraffin embedding. In *Case* 2 these are arranged in groups, of which the individual clefts, lying parallel to one another, are often not clearly differentiated (*Fig.* 30). The different groups show similar orientation in certain fields only. In *Case* 1 the clefts are much more sharply defined, and, while still remaining roughly parallel, have assumed a curious pennate arrangement, with nothing like the same separation into distinct groups (*Fig.* 31). In both cases, but especially in *Case* 2, the fibrocellular stroma separating the groups of clefts contains large numbers of foreign-body giant cells. They lie in close relation to the clefts, which are in fact largely separated from one another by their fine cytoplasmic prolongations. In some fields large masses of clefts appear to be embedded simply in homogeneous necrotic material or granular débris, often with a large number of red blood-corpuscles in the stroma, or free in the clefts. Elsewhere the septa between the clefts are composed of flattened nucleated cells, probably of endothelial origin, and here again many effused red cells may be present. The stroma also contains varying numbers of large endothelial cells with foamy cytoplasm, especially at the periphery of the cholesterin-bearing areas (*Fig.* 32), where they occur in large masses. Many of these cells contain granules of yellowish pigment, some of which give the Prussian-blue reaction. In certain areas the clefts are fewer in number and more discrete (*Fig.* 32), and foreign-body giant cells and foamy cells are then seen in greater profusion. The cholesterin-bearing areas are bounded at the margin by a more or less definite wall of dense fibrous tissue, here and there by cellular granulation tissue.

FIG. 30.—*Case* 2. (Low power.) Note arrangement of clefts in groups. Large foreign-body giant cells are seen in the matrix.

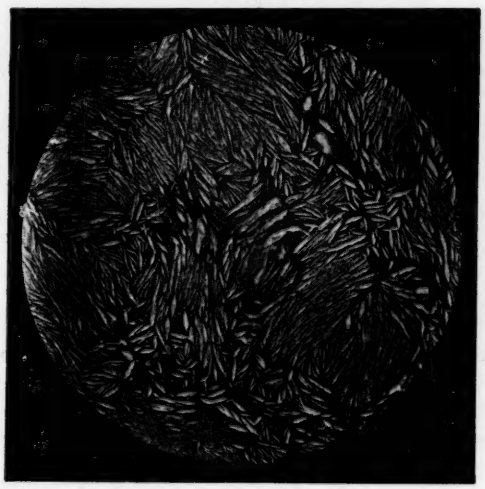

FIG. 31.—*Case* 1. (Low power.) Innumerable cholesterin clefts are seen, arranged in a somewhat pennate fashion.

In frozen sections the masses and groups of tabular cholesterin crystals are very conspicuous, and their optical activity is demonstrated by the use of the polarizing microscope. They give the characteristic microchemical reactions of cholesterin, assuming a rose-pink colour when strong sulphuric acid is run under the cover-slip, and a violet colour, followed by green, and finally black, on the subsequent application of Lugol's iodine. In sections stained with scarlet-R, the foamy cells of the stroma are seen to

be filled with orange-coloured granules and globules, while they take on a violet tint with Nile-blue sulphate-A. In association with them are numerous fine acicular crystals, apparently mainly extracellular, but also in part intracellular, which are also optically active. Exposure to temperatures up to 100° C. has no effect on the large tabular variety (i.e., more or less pure cholesterin), but the acicular crystals are dissolved, mainly at temperatures below 60°. On cooling they assume the form of anisotropic globules (fluid crystals), and are doubtless either compounds or loose combinations of cholesterin and fatty acids. It is found that exposure to 100° C. causes the liquefied crystals to flow together, and so to form, on cooling, anisotropic globules of much larger size than if the section had been heated to 60° C. only.

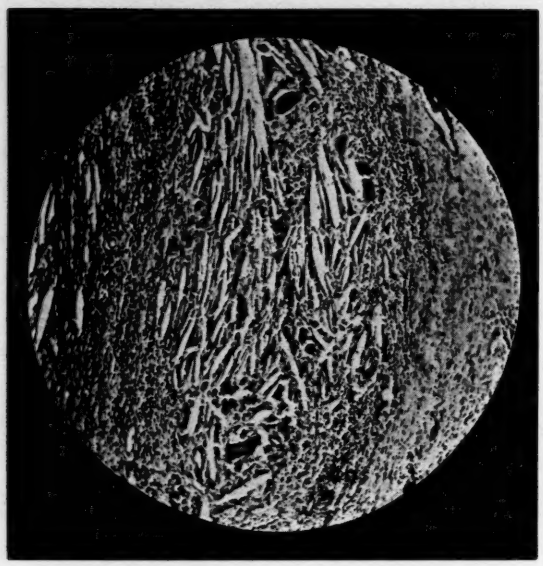

FIG. 32.—*Case* 1. (Low power.) Marginal zone of cholesterin deposit, showing large foreign-body giant cells. The pale area to the right of the field is extensively infiltrated by foamy cells.

## OBSERVATIONS.

The condition here described, of the deposition in the breast of very large amounts of plate cholesterin, is doubtless merely an exaggeration of a process already familiar. The causative factors at work are some of those usually associated with such deposition, viz., the accumulation *in situ* of necrotic tissue, effused blood, glandular secretion, and inflammatory exudate. In the process of disintegration of these substances the more soluble constituents are absorbed, while the less soluble, such as cholesterin and the hæmatogenous pigments, remain in the tissues.

The original lesion in both instances was undoubtedly a mastitis, probably subacute, with acute exacerbations, and in both the condition was of very long standing. In *Case* 1 the affected breast had been the seat of an acute suppurative mastitis thirty-five years previously, but this apparently healed up, and the actual duration of symptoms prior to operation was ten years. There was a slowly-growing mass in the breast, and an intermittent discharge of blood and pus from the nipple. In *Case* 2 the duration of symptoms was no less than twenty-seven years : during the first seven years an intermittent serous or bloody discharge from the nipple, and then a slowly progressive enlargement of the affected breast for about twenty years.

The chief factor accounting for the large size of the cholesterin deposits is obviously the long continuance of the pathological processes concerned. An intermittent discharge of serous or purulent material from the nipple probably implies some degree of intermittent retention of these exudates in the intervals, and this continued for ten years and seven years respectively in the two cases. In *Case* 2, where there is enormous cystic distention with very abundant deposition of cholesterin in the walls, there is also a history of gradual swelling of the breast for twenty years after the discharge from the nipple had ceased.

That there must have been a great deal of hæmorrhagic extravasation into the lesions, probably also intermittent, is shown by the presence of large amounts of hæmatogenous pigment as well as of recently-effused blood.

**SUMMARY.**

1. The cases described are instances of long-standing subacute mastitis where, owing to retention of necrotic débris, inflammatory exudate, glandular secretion, and effused blood over long periods, very extensive deposition of crystalline cholesterin has taken place.

2. The histological appearances in paraffin sections are most striking and characteristic, consisting of an enormous number of clefts, lying parallel to one another in large groups, or arranged in a pennate fashion. The crystals occupying these clefts have the optical and microchemical characteristics of cholesterin. The intervening stroma contains foreign-body giant cells in large numbers, and many 'foamy' endothelial cells, especially round the periphery of the main deposits. The foamy-cell areas contain in addition a large amount of acicular crystalline material which melts at temperatures well below 100° C., and which forms anisotropic globules on cooling (i.e., compounds or combinations of cholesterin and fatty acids).

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# TRAP-DOOR OPERATION FOR EMPYEMA.

By A. N. McGREGOR, Glasgow.

This operation is devised to provide an outlet for the pus of empyema without the use of a tube, by means of a positive pump action which ensures that the pleural cavity is emptied in a very short space of time and the lung brought down to its normal position.

Tubes as a means of affording outlet for purulent fluid have been used for very many years, and are still necessary in certain situations. Their obvious defects are that, by keeping the orifice patent, they are apt to allow of the ingress of air and secondary infections, particularly when they are used in the chest or abdomen. While an ordinary pneumococcic pyothorax may dry up under this treatment in a reasonably short time, it is a common experience that a long period of drainage is required, and in some cases the more serious operation of thoracoplasty follows. It will be obvious that in draining by a tube the influence of gravity is the main factor after the tension or pressure of the over-distended pleura ceases, and at this stage the movements of inspiration and expiration have the alternate effects of sucking in and expelling the contents of the tube. The pleural cavity now contains not only pus but air. The lung content does not descend rapidly, and the unoccupied portion continues to produce pus.

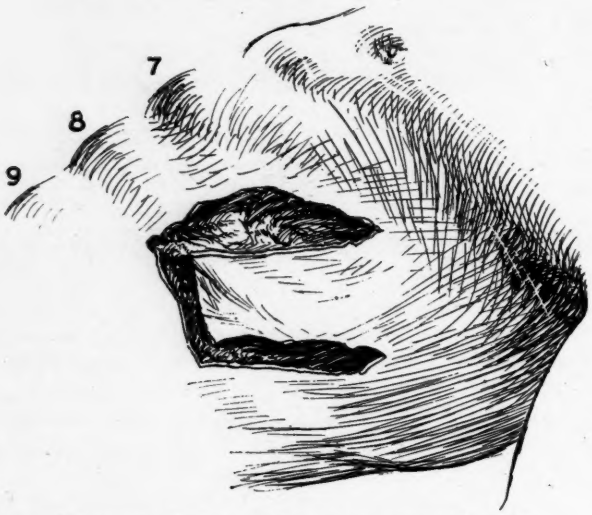


FIG. 33.—To show the position of the rectangular incision.

The object of the procedure now advocated is to provide a flap, rectangular in shape, composed of the whole thickness of the chest wall down to the level of the ribs, and to provide an opening by resection of part of a rib opposite the centre of that flap, so that the pus leaves the chest cavity under the flap during expiration, and the movement of inspiration sucks the flap against the opening, and so prevents the entrance of air.

The following are the steps of the operation :—

*Site.*—The most suitable position is in the axillary line at the level of the 8th rib, but it is sometimes preferable, in emaciated people, to operate more posteriorly near the erector spinæ in order to get a thicker flap.

*Incision.*—The size of the rectangular incision should be governed by that of the patient, and the most convenient guide is to measure from the upper border of the 7th to the lower border of the 9th rib for the vertical portions, and a like distance should separate the lower ends of these incisions (*Fig.* 33). The whole of this flap is reflected upwards so as to expose the ribs, and it is kept in that position by an assistant during the next stage of the operation.

The periosteum of the 8th rib is now incised for a distance of one to two inches,

depending upon the size of the individual. This incision is parallel to the long axis of the rib, and a transverse incision is made at the anterior and posterior ends. By means of a periosteal elevator the periosteum is removed from this section of bone, both on its outer and inner aspects (*Fig.* 34). The bare bone is then removed by means of suitable bone forceps. Sometimes gouge forceps are found to be specially useful for this purpose, particularly in the very young.

There now remain but periosteum and pleura, which should be kept intact up to this point.

The traction forceps are now taken off, and the flap is brought down to its original position. A suture is inserted in each corner of the flap and the corresponding corner of

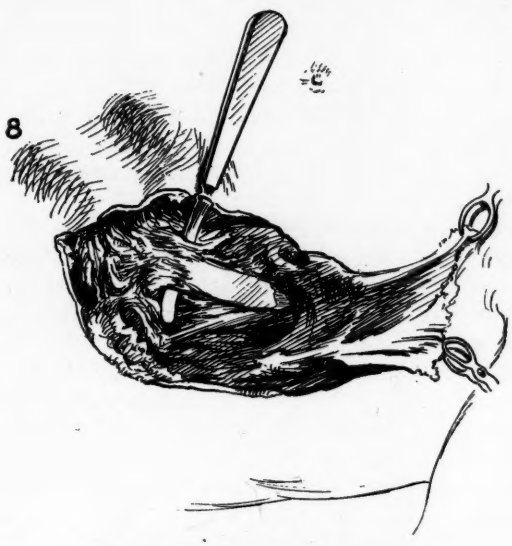


FIG. 34.—Removing the periosteum.

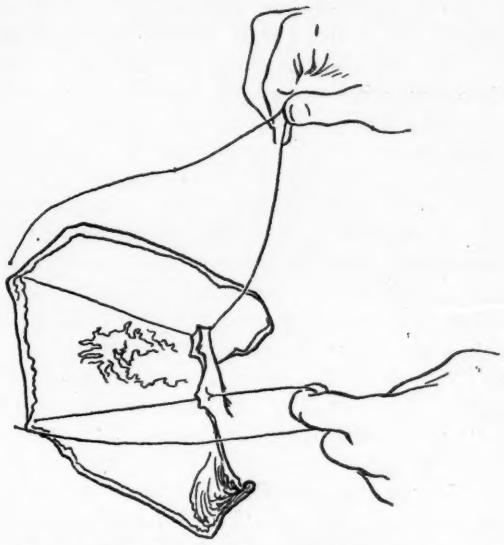

FIG. 35.—Position of the sutures as held by the assistant.

the wound, taking the whole thickness of the flap and a like amount of the adjacent tissues. These two sutures should be long, preferably of silkworm-gut or silk, and the assistant should hold the loose ends with a slight degree of tension while the surgeon performs the last stage of the operation (*Fig.* 35).

This final step consists in raising the lower border of the flap until the gap in the

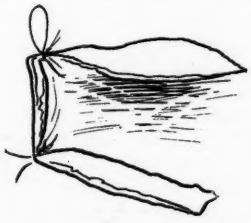

FIG. 36.—Showing flap in position.

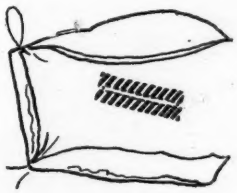

FIG. 37.—Showing relative position of flap, removed rib, and incision into pleura.

8th rib is visible, incising periosteum and pleura there with one rapid cut of the knife, and immediately lowering the flap and holding it in position until the assistant has tied the two sutures (*Fig.* 36).

*Fig.* 37 is a diagrammatic representation of the relative positions of the flap, the removed portion of rib, and the incision into the pleura.

The pus will now ooze out underneath the flap during expiration, and on inspiration a depression of the flap will be seen next the opening of the chest wall. There will be no forcible ejection of pus or inspiration of cold air, and consequently there is a marked absence of cough. The pus is pumped out at a fairly rapid rate during the first ten minutes, and afterwards in smaller and diminishing quantities, until it finally ceases in a period varying from three to ten days. When the discharge has ceased, the sides of the flap may be sutured.

The dressings employed are fairly bulky, and composed of gauze, cellulose, and cotton-wool; they are changed as soon as they are felt to be moist.

This operation was devised about 1912, and was used on many occasions prior to the outbreak of war. Practical experience has enabled many improvements to be made, so that during active service, and since, the procedure above noted has been stabilized, and may be considered well beyond the experimental stage.

Perhaps the most gratifying feature is the quick descent of the lung to its normal situation, which has been frequently verified by auscultation the day after operation. In this connection, however, a word of warning may be offered. In old-standing cases, particularly in the aged, and in those arising out of tuberculous disease where pleural adhesions are likely to have formed, the forceful pump-like action might readily tear these adhesions and cause hæmorrhage or pneumothorax.

*Anæsthesia.*—In a number of cases it was not possible for the patient to assume the recumbent position, and so the commoner general anæsthetics were impracticable. The operations were performed with the patient in the sitting position, occasionally with ethyl chloride or gas and oxygen, more frequently by means of infiltration local anæsthesia. In this last a very weak solution should be used over a large area, and when the flap is resected a further dose should be injected under the periosteum, and in the intercostal spaces above and below the section of rib to be removed. A 1 per cent solution of cocaine in normal saline solution, with 10 minims to the ounce of adrenalin hydrochlor. (1–1000), forms a useful and efficient mixture.

In three cases the patient's condition was so extreme that it was deemed advisable to aspirate some of the fluid before proceeding to the operation. One of these was a case of hæmothorax due to the entry of a piece of shrapnel. When the man arrived in hospital from the convoy he was immediately taken to the theatre, and a fair quantity of fluid blood was removed by the aspirator. Immediately afterwards, under local anæsthesia, the trap-door operation was performed and several pints of blood were removed, in which a fragment of shell was found. Notwithstanding the occurrence of acute nephritis ten days after the operation, the chest condition cleared up rapidly, and the patient eventually made a good recovery.

Quite recently a patient was admitted to the Glasgow Royal Infirmary whose condition was considered inoperable until the intrathoracic pressure was relieved by aspiration. Following are the details:—

Patient, male, age 11, admitted on Feb. 18, 1920, suffering from left pyothorax. Ailment of five weeks' duration. On admission, the pulse was 120, temperature 100·8°, and respirations 52. Patient was very weak and emaciated, and was unable even to sit up in bed. There was a slight flush over the malar prominences, and circumoral pallor. Dyspnœa was marked; the intercostals of the right side and the alæ nasi were moving rapidly. The chest was asymmetrical, the left side being slightly bulged and the intercostal spaces indistinguishable from the rib curves. The apex beat was in the 3rd right intercostal space, almost in the right nipple line.

On palpation, the left side of the chest was not moving with respiration. No vocal fremitus was felt. On percussion, the whole of the left side of the chest was dull. The cardiac dullness extended one inch to the right of the right nipple. On auscultation, the cardiac and pulmonary conditions were substantiated.

The patient was too ill for radical operation, and therefore 52 ounces of thick foul-smelling pus were aspirated. Next day the trap-door operation was performed and about 2½ pints of pus were evacuated.

Progress was uneventful. Discharge had practically ceased by March 2, and patient was fit for dismissal on March 18.

In conclusion, it may be stated that this operation is a means by which a flap of soft parts sufficient to cover the opening in the chest-wall is employed to prevent the entrance of air during inspiration, but so loosely sutured as to allow of the expulsion of pus during expiration, thus utilizing the ordinary respiratory movements to provide the power of the pump.

It is important to note that the flap should be ample, so that its edges may not be drawn into the opening in the chest wall. In the earlier stages circular and oval flaps were tried, but for the last five years the rectangular shape has been found the most satisfactory.

I have to thank Mr. A. J. Couper for much valuable assistance during the practical application of the principles of this procedure, and I am especially indebted to Mr. F. A. Farrell for the accompanying diagrams.

# THE TREATMENT OF TUMOURS BY RADIUM AND X RAYS.

By NEVILLE S. FINZI, London.

*Report to the Vth International Congress of Surgery, Paris,* 1920.

In the treatment of malignant tumours we have to consider: (I) *The action of radiations on tumours;* (II) *The forms of tumour for which radiation should be used;* (III) *The type of radiation to be used;* (IV) *When and by what method it should be applied;* (V) *After-effects of radiation treatment, and how to avoid or minimize them.*

## I. THE ACTION OF RADIATIONS ON TUMOURS.

When the radiations, either of radium or *x* rays, are applied to the tissues, they will, if a sufficient dose be given, cause a destructive effect. Fortunately, however, the dose requisite to produce destruction is very different for different types of cell, and in many malignant tumours the dose required to kill the tumour cell is only a small fraction of that which destroys healthy tissues. The different types of healthy cell vary considerably in their sensitiveness to radiations, but a particular type in a particular part of the body has always approximately the same sensitiveness. Thus glandular tissue is more sensitive to the rays than epithelium, and epithelium more than muscle, but the epithelium of the tongue is more sensitive than that of the skin, and much more so than that of the vagina.

The different growths also vary much in their sensitiveness to the radiations; but, with certain limitations referred to later, each tumour has its own characteristic response according to its type, situation, and stage of development. The same type of cell will respond somewhat differently to different types of radiation, and this will be discussed when considering which radiation to use.

What we aim at in the radiation treatment of malignant disease is extirpation of the growth *in situ* without destruction of the surrounding tissues. This latter must be avoided as far as possible, since it impairs the efficiency of the result by preventing the healthy tissues from dealing effectively with what remains of the growth, by delaying healing, by rendering the part more prone to sepsis, by causing pain and absorption of toxic material, and, more important, by preventing subsequent irradiation of any tumour cells which have not received a lethal dose of rays, and this is not infrequently the case. It is at present not possible to say whether the irradiation of the surrounding tissues stimulates them to resist the invasion of a growth: a dose considerably below that which would cause damage would probably stimulate them.

There is another object in the irradiation treatment of tumours. It has been shown, by experiments on mice, that a tumour which has been removed from the body and then exposed to a sufficient dose of radium or *x* rays, cannot be implanted into another mouse. Further, if the irradiation is just sufficient to inhibit the growth of the tumour and no more, a degree of immunity is conferred on the animal into which the growth is inoculated; but with a larger dose of rays no such immunity is conferred. It is possible, therefore, to prevent implantation of tumour cells into healthy tissues during an operation by a previous irradiation.

I will refer here to some experiments on minute doses of *x* rays applied to the whole body, carried out at the Middlesex Hospital. It was claimed that a single very small dose of *x* rays produced in rats a great increase of leucocytes, and inhibited or prevented the growth of a tumour subsequently implanted. An examination of the table of experi-

ments, however, shows that in quite a large proportion of the animals experimented on, the growth was not inhibited, and probably the proportion of unsuccessful inoculations is not so much greater than in the controls as to exceed the limits of experimental error. The applications of these experiments to human beings is not recorded. The results, too, are so much against the views derived from clinical experience, that it is a satisfaction to be able to ignore them.

The action of the rays on the same type of tumour is not always the same. There comes a stage in every growth when the rays will no longer differentiate to the same extent, or even will not differentiate at all, between the tumour cells and the healthy cells. In some growths it is earlier and in others later: it is even possible that every growth at some stage would have been curable by radiation treatment. The earlier any type of growth is taken, the more sensitive is it to the rays. Nevertheless, however early a growth is taken, it will vary in its response in accordance with its specific type. This diminution in sensitiveness is usually a slow process, and we know of no means apart from clinical experience of determining the exact time at which irradiation becomes ineffectual. It appears that in some growths a period exists when $x$-ray treatment fails, while radium is still efficacious. When the curable stage of the disease is passed, it is often still possible to obtain relief with radiation treatment.

Can radiation treatment do harm? The answer is in the affirmative; but when it does, bad technique is usually the cause. An insufficient dose applied to a refractory tumour may stimulate its growth.

Excessive treatment will do harm, as already pointed out, and it may also delay healing of a wound in a subsequent operation. There is also the question, especially in irradiating large areas of the body, of the effect of the rays on the other tissues, particularly the leucocytes. We know comparatively little at present of the effects of large quantities of radiation upon the blood, and it might be possible to damage the patient's resistance to the growth. In ordinary doses this does not appear to occur. Recent work at the Radium Institute of London has shown that *prolonged* exposure to small doses of $\gamma$ rays from large quantities of radium results in marked leucopenia. It is pretty well established that the irradiation and absorption of one metastasis will exert a beneficial effect on a distant one, but the actual disappearance of a non-irradiated metastasis as the result of irradiating the primary growth or another metastasis has not been recorded.

It will now be obvious that irradiation of a growth may be used for several purposes.

1. **Prevention of Inoculation of Tumour Cells into a Wound** at a subsequent operation, or when a piece is removed for microscopical examination.

There is no doubt that irradiation should be much more widely used than it is at present for this purpose. In any case where it is possible that the growth might be of a type sensitive to $x$ rays, this method should be used. Naturally, in a growth of a type obviously unsuitable for irradiation, it should not be employed, as it might lead to stimulation of the growth. An instance of this is the usual infiltrating type of epithelioma of the tongue.

In the surgical extirpation of a tumour the surgeon must of necessity often cut through tissues which contain elements of neoplasm, possibly microscopical: at the same time the lymphatic spaces are opened and these elements become implanted in the tissues around. Results show that local recurrences are frequent. Now, if these cells are rendered unimplantable, local recurrence can only occur from tumour cells actually left behind which have not received a sufficient dose of irradiation, and the possibility of these should be dealt with by subsequent prophylactic treatment.

The practice of cutting into a growth to remove a portion for microscopical examination may lead to widespread dissemination if the tissues have not previously been irradiated. Provided the section is made within two or three days after the irradiation, no alteration in the structure of the growth can be detected, and consequently the microscopical diagnosis is not interfered with.

Care must be taken not to damage the skin in irradiating; otherwise healing will be delayed. Operation can be carried out at any time during the fortnight following the

irradiation: it is better not to attempt it during the reaction period which occurs in the third week following the irradiation; nevertheless, if circumstances demand it, an operation in this period is not contra-indicated.

2. **Destruction of the Growth** *in situ*.—This is used in the types of tumour which respond most readily to radiation treatment, also when more resistant types are treated in inoperable or in recurrent cases. It can be effected by burying radium in the growth, by using radium rays from outside the skin or inside one of the cavities in the body, by using *x* rays from outside, by opening up the growth and then exposing to *x* rays, or by a combination of these methods. Treatment of recurrences comes under this heading.

3. **Treatment for Relief of Pain and Discomfort.**—Though, in the treatment of growths with the object of producing a cure, we may, as the result of the large doses given, sometimes cause considerable pain, irradiation treatment, as a rule, greatly eases pain; consequently, it is often used for this purpose in quite incurable cases.

Radium is also employed to keep a carcinomatous stricture patent, especially in the œsophagus. Gastrostomy by no means replaces radium in this disease, as it does not relieve the patients' chief discomfort, the quantities of mucus which they continually bring up when there is a tight stricture. In the treatment of a stricture of the rectum, radium may or may not save the patient from a colostomy; in successful cases a fibrous stricture is left which may necessitate bougieing for many years.

Radium is also wonderfully efficacious in stopping hæmorrhage from a growth when this is not from a big vessel, and is sometimes used solely for this purpose even in tumours otherwise refractory to radiations.

4. **To Render Inoperable Growths Operable.**—It is sometimes possible to achieve this object, and if the growth is of a refractory character, it is best to seize the opportunity rather than rely on continuing irradiation. The rapidity with which a growth reacts to radiation is a good criterion of its sensitiveness; the quicker the diminution, the more certain the local result.

## II. THE FORMS OF TUMOUR FOR WHICH RADIATIONS SHOULD BE USED.

We find that, although there are some notable exceptions, the growths which respond most readily are those which grow the most rapidly. The chief exceptions are, on the one hand, epithelioma of the lip and rodent ulcer—very slow-growing tumours which respond readily; and, on the other hand, epithelioma of the tongue or vulva—rapidly-growing tumours which do not respond to radiations.

The classification at present will be approximately as follows:—

Category A.—**Growths to be Treated by Radiation in preference to Surgery.**—Lymphosarcoma; rodent ulcer.

Category B.—**Growths in which Surgery or Radiation Treatment is optional** (*prophylactic radiation used in either case*).—Endothelioma which has assumed malignant characteristics; epithelioma of the lip; epithelioma of the skin (early stages); the cauliflower non-infiltrating type of epithelioma of the tongue or palate; epithelioma of the penis (ordinary type); carcinoma of the body of the uterus.

Category C.—**Growths for which Surgery is preferred to Radiations, but for which Prophylactic Radiation is used.**—Carcinoma of the breast; carcinoma of the rectum; carcinoma of the ovary; carcinoma of the cervix; epithelioma of the tonsil, floor of the mouth, larynx, pharynx, skin (later stages), anus; spindle-celled sarcoma; alveolar sarcoma; melanotic sarcoma; hypernephroma; glioma.

Category D.—**Growths for which Radiation should not be used.**—Epithelioma of tongue (infiltrating type); epithelioma of vulva.

*A*. In some growths response is so good that radium or *x* rays must replace surgery. It has long been recognized that radium treatment of rodent ulcer is far and away the most successful, especially if applied before other treatments have been tried and failed. In these cases, if rightly employed, success should be obtained in more than 95 per cent of cases, and probably in more than 99 per cent.

We have now to claim another type of tumour from the hands of the surgeon—lymphosarcoma. I have for many years held the view, and increase of experience confirms it, that this disease should never be treated by surgery except to insert radium into the tumour. It is a rapidly-growing tumour and, unfortunately, too much time is usually lost before the radiologist is called in; then the patient shows general metastases in the lungs, the liver, and elsewhere. This particular type of growth is so susceptible to radiations that even metastases may be treated so long as they are not too widespread.

*Example.*—I was called to see a patient in 1913 who had a large mass in his right groin about 10 to 13 cm. in diameter, a still bigger mass in his right iliac fossa, and a mass in the right lobe of his liver; a scar on the forehead which he had had for many years had recently become much thickened and very red, and it is quite possible that this was the source of the disease. Unfortunately, no section was made of the growth, but the clinical appearances and the subsequent course of the case left no doubt in the minds of those who saw it that it was a lymphosarcoma. The scar on the face was treated with filtered radium rays, and the rest of the disease by intensive doses of filtered *x* rays. Improvement was striking and rapid, but treatment was continued many months after all obvious signs of the disease had gone. Some months after treatment had ceased, he developed a late *x*-ray reaction which, however, we were able to preserve from ulcerating. The next event was that he joined the army early in the war, and rose rapidly from the rank of private to that of major. In the course of this procedure, he received a fairly severe wound in the leg, in 1915. In 1916, rather more than three years after the disappearance of the original growth, he had a recurrence in the *left* side of the neck. Intensive *x*-ray treatment of the neck and the mediastinum got rid of this, and he remained free from trouble until 1919, when he developed great pain in the back and left side, and when at last we got the army authorities to send him back from Cologne we found that he had a recurrence in the spleen. A short course of intensive *x*-ray treatment got rid of this, and when I last heard from him he was quite well.

Dominici showed a case years ago in which we had treated successfully several large recurrences of a sarcoma of the testicle, one being a great mass in the lumbar region.

*B.* We do not yet claim, as a right, any other forms of *operable* tumours, though there are some in which the patient might be given the option. For instance, endothelioma responds so well that a patient who demanded radiation treatment in preference to operation would not be unreasonable. When I say endothelioma, I mean the type commonly recognized as such, and not that which some pathologists call endothelioma and others epithelioma. The commonest situations of the true type are, of course, the parotid and the palate.

Carcinoma of the *body* of the uterus is another type where the treatment might perhaps be optional, but surgery is very successful in most of these cases. With the employment of larger quantities of radium, and with its use in earlier cases, and their more thorough after-treatment, we are likely to have to bring a much larger number of cases into this or into the first category in the near future. For instance, in several clinics radium is already being used as the treatment of choice in carcinoma of the cervix, a disease which, in its later inoperable stages, is only moderately susceptible to the radiations.

The earlier treatment by radiations of carcinoma of the rectum, and of epithelioma of the tonsil, pharynx, bladder, or skin, combined with improved methods of treating these cases, such as by embedding the radium aseptically into the growth or even into the tissues around it, seems likely also to result in a modification of the views at present held about them.

Epithelioma of the lip can be very successfully treated with radium, and consequently falls into the category of cases in which the patient should have the option of radiation treatment.

*C.* The third category consists of cases which are more refractory to radiation treatment, and where an operation is advised whenever possible. The question of pre-operative and post-operative radiation depends on the susceptibility of the particular type of growth. Carcinoma of the breast, for instance, does not react readily enough to advise radiation treatment alone, so that one always recommends operation where possible: nevertheless recurrences of this tumour may be cured with radiations, and therefore one should be able to cure a certain number of primary growths; long and continued treatment, however, is necessary. Obviously, therefore, the best method is to get these cases early, treat them

prophylactically with radiations, and operate as completely and thoroughly as if no radiation treatment were being used. This category contains a very large proportion of the total number of cases, owing to carcinoma of the breast and of the rectum being included in it. Epithelioma of the cheek and of the floor of the mouth might also be placed under this heading, but they are more refractory than the others mentioned. When growths in this category are inoperable, or when operation is contra-indicated for some other reason, they should be treated by radiations, especially the more susceptible types.

*D.* The fourth category includes cases which are so refractory to radiations that one risks exciting them to increased activity by giving insufficient doses to the outlying parts. Such growths are the infiltrating epithelioma of the tongue and the ordinary type of epithelioma of the vulva. Radiations must sometimes be used in these cases for the relief of pain or hæmorrhage.

Inoperable growths in *Categories B* and *C*, or cases in these categories in which, for some reason, operation is contra-indicated, will, of course, be treated by radiation, and in these will be included carcinoma of the œsophagus.

### III. THE TYPE OF RADIATION TO BE USED.

Physicists tell us that it does not matter what radiation we use so long as the amount absorbed by the tissue irradiated is the same. Practical clinical results do not confirm this. In my experience, and I believe that the majority of radiologists agree with me, the more penetrating the radiation the more satisfactory the results. It may be that the more penetrating radiations permit of greater doses being applied to the tumour without damaging the skin ; but the amount of radiation absorbed when using the $\gamma$ rays of radium must be infinitesimal, and yet this appears to be the more useful radiation even for the most superficial growths if one can get it in sufficient quantity ; when using radium, however, this is the difficulty. Some experiments were conducted at the Middlesex Hospital, London, during the winter, but at the time of writing they are incomplete. Five grams of radium bromide were used, and all the applications were external. Some of the cases I saw being treated in this way I should consider quite unsuitable for radium treatment in any form. An attempt is being made to confine the treatment to one single dose, though of course this sometimes needs to be subdivided into two applications : this in itself will prevent the results being as good as one might otherwise expect, as clinical experience has shown how necessary it is to give several doses, including prophylactic radiations. I hope to give some later information as to these experiments by the time of the Congress.

Experiments conducted at the Middlesex Hospital with comparatively small and comparatively large quantities of radium have shown that when a tube is inserted into the anus of a rat so that it lies partly against the squamous and partly against the columnar epithelium, using the same dose in millicurie-hours, a small quantity for a long time has more effect in destroying squamous epithelium, while the reverse obtains with columnar epithelium. I am told this experiment can be repeated time after time ; I should, however, like to see it confirmed by the use of another pair of tubes constructed on similar lines and with a greater difference between the amounts. Can these experiments be taken into account in the treatment of tumours ? I think not. The epithelial cells found in an epithelioma are not normal, and do not behave like normal epithelial cells. The matter has not yet been finally decided, but the results with *x* rays applied to epithelioma of the tongue have been even worse with small doses applied frequently than with large doses applied seldom.

From what has been stated it will be gathered that radium $\gamma$ rays are superior to *x* rays if both can be applied in the same amount. Therefore even for superficial growths the $\gamma$ rays will be the method of choice. But what about the $\beta$ rays of radium ? The great work that Dominici did was to show that when a certain thickness of filtration is used—2 or 3 mm. of lead—the results are much better than with less filtration. Dominici thought that hard $\beta$ rays still got through 3 or 4 mm. of lead, but subsequent

experiments by physicists have shown that practically this is not the case, and that 4 mm. of lead or 2 mm. of platinum is sufficient to cut off approximately all the β rays.

In the treatment of malignant disease, therefore, β rays are not to be recommended. Even in rodent ulcer it is best to filter off the majority of these rays, and I have cases of rodent ulcer where β-ray treatment failed and γ-ray treatment succeeded.

Of the action of the α rays on malignant tumours I have no knowledge: it could be tried by using polonium. Their penetration is so small that successful results would not be anticipated.

Unfortunately the quality of the radiation is not the only problem we have to consider. Our chief difficulty is to drench the tissues most distant from the source of the rays with a dose sufficient to destroy any elements of growth without exerting a destructive effect on normal tissues which are nearer to the source. Now it is found much easier to do this with heavily-filtered *x* rays than with the small quantities of radium ordinarily in use (I refer to 100 to 300 mgrm. as a small quantity). Nevertheless, I believe that massive doses of radium irradiation applied in a similar way to *x* rays would give better results.

My observations lead me to disagree with the theory that some growths are more sensitive to radium and others to *x* rays; I believe that all are more sensitive to γ rays of radium, but it is a question of the accessibility and distance of the furthest tumour cells. Take a common case, a recurrence in the skin in a case of carcinoma of the breast which has been operated on but not treated prophylactically. We know that radium will get rid of it much more easily and quickly than *x* rays; notwithstanding this we employ filtered *x* rays, because there are certain to be other elements of growth left behind in other parts of the pectoral, axillary, or clavicular regions. Or again, take a case of lymphadenoma or lymphosarcoma of the neck. We know that we can get a locally successful result with radium more quickly than with *x* rays; but the treatment we recommend, even if radium is used, is *x* rays as a preliminary, to prevent implantation or metastases when the radium is subsequently buried in the growth; then radium treatment followed by *x*-ray treatment to destroy the most outlying portions of the growth. In some cases the radium is not even necessary, as they react so well to *x* rays, but this will depend on the type of case.

*Example.*—I saw a patient, in 1914, with a sarcoma of the tongue and huge masses of glands in the right side of the neck, enough to cause complete paralysis of the phrenic nerve. There were also enlarged glands in the left side of the neck, and probably in the mediastinum. A preliminary irradiation was given to the neck; a few days later a 100-mgrm. radium tube with a 2-mm. platinum filter was inserted into the tongue by the aseptic route, i.e., through the median raphe. Filtered-*x*-ray treatment of both sides of the neck and chest was continued for six months. The patient remains well six years after the treatment was commenced.

With a comparatively limited growth such as a sarcoma of the muscles of a limb, where we can apply the radium at different points on the circumference, it may be possible to carry out the prophylactic treatment by radium, and then one should give two treatments after the growth can no longer be detected by manual examination.

Filtration in radium treatment cuts out the α and β, and the soft γ rays; in *x*-ray treatment it cuts out the rays of longer wave-length, the less penetrating rays. In treating tumours which are quite superficial, we filter both radium and *x* rays just the same. The reason for doing this is chiefly that we increase the relative difference of the action of the rays on healthy and tumour cells. The fact that we also diminish the amount of radiation absorbed in the superficial layers, so that the depths receive a greater quantity, is important; but it is insignificant compared with the other effect. This cannot be too strongly insisted on, as the results of treatment by filtered radiations, even in the most superficial growths, are incomparably superior to those obtained by unfiltered rays; one may even convert failure into success by using thicker filters. The amount of filtration or screening to be used is not yet finally determined.

In radium treatment, 0·5 mm. of platinum or 1 mm. of lead or silver suffices for most rodent ulcers, but occasionally one has to use more. For other growths I consider that 2 mm. of platinum or 4 mm. of lead or silver are necessary; some substance must be used to absorb the secondary radiations, even when the radium is buried. For *x* rays, 3½ mm.

of aluminium are the minimum, and probably 5 or even 10 mm. are better. Pure aluminium is the best substance to use for filtering *x* rays, as any secondary rays from it will be absorbed by a few centimetres of air if this space be left between the filter and the patient's skin. It has the additional advantage that it is not bulky, and the dose can be measured after it has passed through the filter.

In filtering radium rays the thickness of aluminium required would be enormous; therefore, to get the filter into the smallest possible compass we use the densest workable metal obtainable, and this is platinum. The secondary radiations may be filtered off by a sheath of rubber or a thin layer of aluminium.

### IV. WHEN, AND BY WHAT METHOD, RADIATION SHOULD BE APPLIED.

1. **In Treating Growths by Radiation Only.**—It is almost superfluous to point out that the earlier the case is treated, the greater will be the probability of a successful result. Surgeons have long insisted on this with regard to operation, but they seem to forget that it applies as much or even more to radiation treatment. A stage occurs in every malignant growth when it no longer responds to treatment by rays. Successive doses of rays seem in some cases to exert less and less effect; but it is possible that this is only because it is a later stage in the course of the disease. There is no object in treating a patient at death's door with rays; it merely provides material for ignorant critics of irradiation treatment. There is perhaps an exception to this statement. I have seen patients with lymphosarcoma who have been dragged back to life when almost at their last gasp, and who have lived for months or even years.

The next great truth is that we have not yet arrived at such perfection of technique as to be able to treat cases with one dose only. It is true one may have an occasional success if one does this, but the number of curable cases which will be lost will be most disheartening. The irradiations must be repeated for some time after all clinical signs of the disease have gone. In using radium rays I try to give two applications after the patient is apparently cured. With *x* rays I like to continue for six months after the disappearance of the growth. I find that growths disappear more rapidly under radium than *x*-ray treatment.

Many cases of malignant disease are lost by failing to treat the lymphatics and the glands draining the affected area. This is just as important as in treating such cases surgically. It is not usual to bury radium tubes in these situations, owing to the difficulty of obtaining even action over a large area; they are treated by external irradiation, using radium if possible, *x* rays if not. A combination of radium treatment of the growth and *x*-ray treatment of the glands will sometimes be advisable.

In using radium, the next question is whether it should be buried in the growth or be used from outside. Experience leads more and more to the view that it should be buried whenever possible. After the growth has disappeared, radium should be used from outside, taking care to protect the skin by irradiating from a distance.

A method comparable with burying radium has been used with *x* rays; the growth, having been exposed by a surgical operation, is thoroughly irradiated and the wound closed. I have no experience of this method, but it may be sound for some cases.

In treating a malignant growth attention must always be fixed on the furthest ramifications of the disease, as, unless these be given a lethal dose, the treatment will fail. Any part of the growth which receives an overdose may be disregarded so long as it is kept aseptic. More care must be taken with healthy tissues, but even these will stand much larger doses than the skin if no micro-organisms be allowed to obtain access.

The asepsis required in burying radium or in opening up a growth for *x*-ray treatment is of the most thorough kind. Healthy tissues can stand a big dose of germs without suppuration, but those damaged by rays form an excellent culture medium for quite a small dose. As much attention, then, must be paid to this question as in the most exacting major operations or as in operating on a diabetic.

Radium will be used in preference to *x* rays in every case in which the outskirts of

the tumour are likely to receive a lethal dose of radium rays. In either case the radiations must be well filtered for the reasons already given. With radium it is a good general rule to use sufficient to give the requisite dose in less than two days, though extensive superficial recurrence may sometimes need longer treatment. It will often require all the skill and experience of the radiologist to balance the greater differentiating power of radium rays against the greater ease of flooding the whole growth with irradiation by filtered *x* rays. In the more refractory types of growth, *x* rays fail where radium succeeds, especially in the epitheliomata. There are even cases in *Category B* for which *x* rays are of little value, yet which react readily to radium, e.g., epithelioma of the lip.

The amount of filtration advisable with radium is 2 mm. of platinum or the corresponding amount, 4 mm., of silver or lead. Platinum is usually the best, as it occupies much less space. In treating rodent ulcer 0·5 mm. of platinum will be found sufficient. The secondary radiations from the metal must be cut off, and I believe this to be advisable even when burying the tubes. Burying a tube with an inadequate screen, or one in which the secondary rays are not filtered off, is liable to lead to necrosis even if the operation is aseptic; of course too large a dose of rays might produce the same effect.

The effect of radiations on a septic growth is curious. If the growth reacts readily, the sepsis rapidly clears up; but if the growth is refractory, the sepsis is likely to get much worse. Unfortunately the $\gamma$ rays have no bactericidal action, and consequently do not improve the condition directly.

The amount of filtration advisable with *x* rays appears to be a minimum of 3·5 or 4 mm. of aluminium. The *x* rays, however, must be 'hard' before passing through the filter.

It is found that with a filter of 3·5 mm. of aluminium most patients can stand a dose of 7 H (Holzknecht units) every three weeks for a long period, and with a filter of 5 mm. they can stand 8 H. My opinion is that a maximal dose given every three weeks is more effective than smaller doses given more frequently. With radium treatment there seems to be even less doubt on this point than with *x* rays. The radium treatments, however, cannot be applied more frequently than every six weeks if maximal doses are given, and their effects are much more lasting than *x* rays.

2. **In Combined Radium and Surgical Treatment.**—In surgical treatment we include not only removal by the knife, but other surgical methods—actual cautery, diathermy, etc. Let no surgeon be lulled into a sense of false security by the fact that radiations are being used in addition to surgery. The best results with tumours in *Category C* (and *B* when surgery is chosen) will be obtained by the most thorough surgical removal combined with the most thorough irradiation. From what has already been said, it will be obvious that the growth should be irradiated before the operation, and the best time to operate is within a fortnight after this. The *x* rays will generally be used in preference to radium, owing to the wide area to be flooded with the rays; but if a very large quantity of radium is available it would be better to employ this. The same filtration and doses should be adopted as in treating tumours without surgery, great care being taken not to damage the skin.

Subsequently to the operation prophylactic treatment must be undertaken. It is not possible to say exactly how many doses should be given. I find that one gets very good results by giving *x*-ray treatment every three weeks for six months, and then a further three months' treatment after a rest of three or four months. Possibly less might suffice, especially for a case in *Category B*, but it is better to continue too long than give too little irradiation.

When treating a case of carcinoma of the breast, or sarcoma of any part of the body, the radiologist will be wise to examine the lungs, and in the former case the mediastinum, by *x* rays. Very often this will prove that what was meant to be a prophylactic treatment is nothing of the sort, but is really treatment for cure or for relief.

Combined treatment has been found an advantage in epithelioma of the tonsil, in which case the glands and the portion of the growth in the neck are treated with radium, while the intra-oral part is best dealt with by diathermy. A word of warning is necessary

here; for many cases, treated with radiations, do not receive big enough doses. The skin after thorough treatment should become well pigmented, and, after the lapse of two or three years, should usually develop telangiectases. The surgeon must not hold up the results of inefficient irradiation as indicating that radiations in general are not of value.

For the following reasons I am not in favour of removing as much of a growth as possible before inserting radium: (1) The growth forms an excellent medium in which to insert the radium, and though the central parts of the growth will receive an overdose, this will do no harm so long as asepsis is maintained. (2) It is possible that the preliminary irradiation may not have been thorough enough to prevent completely implantation of every part of the tumour. In this case the opening up of lymph spaces may be dangerous. (3) The trauma of a cutting operation followed by that of a radium application often results in severe sloughing, and seems to render the part more than ever liable to sepsis.

I am not in favour, as a rule, of using radium prophylactically by inserting it in the tissues. If employed in this way it is best to wrap the tubes up in a considerable thickness of gauze, and so get a more even action over a larger surface: but it is difficult to flood the suspected area with an efficient dose of rays.

It sometimes happens that an inoperable growth may become operable as a result of radium treatment. If it is in *Category C* it is best to do a thorough operation and follow this by prophylactic treatment. Here I am in favour of prophylactic burying of the radium tubes at the time of the operation, especially if all future close access to the operation area will be cut off by the operation, as in the cervix or rectum.

*Example.*—A case of a very large inoperable growth of the rectum was treated by radium, with the result that it shrank to half its size and became operable. The abdomino-perineal operation was performed, and radium tubes, enveloped in gauze, were left in both abdominal and perineal wounds. Before the perineal wound closed up, a further prophylactic application was made, and the patient was well when last heard of six years later.

Another aspect of combined radium and surgical treatment is presented when a growth to be treated by radium is in a situation difficult of access. As this usually means a short anæsthetic for the extraction of the tubes as well as a longer one for their insertion, it may be a determining factor in the method of treatment adopted. It is possible to insert radium into such situations as the brain, the base of the skull, the anterior mediastinum, the peritoneum, the prostate, etc. The route of approach must always be an aseptic one. The tongue is approached through the medium raphe, the prostate through the perineum, and the pituitary fossa by the temporal route.

These treatments need courage on the part of both surgeon and patient, especially as more than one must usually be given; but there is much room for development along these lines by a clean and courageous surgeon. It is advisable, as soon as the growth is reached, to use only blunt instruments; but a trocar and cannula are sometimes employed, the former being replaced by a radium tube with pointed end. The skin wound should be sewn right up, and the threads attached to the radium tubes buried in the wound; otherwise the micro-organisms will spread along these threads from the skin. Sutures may often be put in double, the one being tied when the tubes are inserted, and the other left until the tubes are removed and then tied.

## V. THE AFTER-EFFECTS OF RADIATION TREATMENT.

**Irradiation Sickness** is one of the troublesome results of deep *x*-ray therapy, especially if the liver or the pelvic organs be irradiated; but it sometimes occurs with extensive irradiations of other parts of the body, and always if the area treated is sufficiently extensive. The administration of 1 grm. of calcium glycerophosphate three times a day, commencing the day before, and continuing until the day after, the treatment, is sometimes, but not always, effective in preventing or alleviating this condition; probably the calcium is the active agent. The other method of combating this trouble is to spread each

treatment over two, three, or even four days, repeating the first area treated three weeks from the first day, and so on.

**Surface Effects.**—If a skin area is treated thoroughly with filtered *x* rays or with radium, a good deal of pigmentation always results. This disappears in time; but one to three years later telangiectases often develop. This is a minor matter, and cannot be taken into account in dealing with malignant disease; but if necessary the telangiectases can be treated by electrolysis after they have fully developed. If a hair-bearing area be treated, such as the skull, it will become permanently epilated.

When treating a tumour through the skin, one must give a dose heavy enough to cause some erythema. With *x* rays this does not usually occur with the first dose. It comes on about sixteen or seventeen days after a subsequent dose, and as a rule lasts only three or four days. It is generally followed by desquamation, but this may also occur without obvious erythema.

With radium the erythema usually comes with the first dose, and, when a 2-mm. platinum filter is used, it is not seen as a rule before fourteen or fifteen days. As the erythema subsides, the skin tends to become covered with an adherent crust of heaped-up epithelium, especially if a thinner filter has been used. A second erythema is occasionally seen about five, six, or even seven weeks after treatment. In all cases I have observed, it has been milder than the first reaction. These skin effects may often be avoided when the radium is buried.

The epithelium of the tongue and palate is more sensitive than the skin, and these parts must be protected whenever possible.

**Late Irradiation Effects.** — It occasionally happens that one gets what has been called a 'late radium burn' or 'late *x*-ray burn'. I have now seen a number of these cases, and am convinced that they are different forms of infection in tissues damaged by the rays. They occur from one to four years after the commencement of the treatment, and may start any time up to two or three years after its cessation. The late effect may come on during the course of the treatment, if this is prolonged.

There are two main varieties, *acute* and *chronic*. The acute variety commences very like an erysipelas, and spreads rapidly to the whole irradiated area; it is accompanied by rise of temperature and, sometimes, rigors. The whole area becomes acutely tender and much swollen. Unless great care is taken of the damaged part in this stage, it is likely to ulcerate and pass into the chronic form. The treatment is rest and protection of the affected part from any trauma. If the patient must still be irradiated, care must be taken that no rays fall on the affected parts. The only local application advised is a powder of bismuth carbonate, zinc oxide, and starch; antiseptics must not be used.

The chronic variety commences as an ulcer with an indolent surface, very prone to form tough adherent crusts, and this ulcer always has a very bright red edge which is characteristic. This form does not usually spread over the whole irradiated area, and often remains confined to a small surface. The only treatment that appears to be of use is vaccination with autogenous vaccine and protection of the part. Even with this, healing is much delayed. There is no doubt that some profound change takes place in the irradiated tissues after a long period.

## TREATMENT OF BENIGN TUMOURS.

1. **Action of the Radiations.**—What has been said about the action in malignant tumours applies in many cases to benign growths also. There are, however, special considerations. Radium rays, both $\beta$ and $\gamma$, but especially the former, have a marked action on the endothelium. The $\beta$ rays cause considerable swelling of this tissue, a fact which is made use of in the treatment of angioma.

2. **Forms of Benign Tumour to be Treated, and the Type of Radiation to Employ.**—

*Angioma.*—All angiomatous tumours respond to radium treatment. The spider nævus, for which electrolysis is more suitable, can hardly be called a tumour. There

is no method which leaves so little scar as radium in these nævi. If the tumour involves the actual skin a mark is bound to be left, but even then it is much less than that produced by carbon-dioxide snow or electrolysis.

The penetrating β rays are the best for this condition. The γ rays cannot be excluded ; but as they have in themselves a beneficial action on these growths they do no harm. The best results are obtained by screening with 0·1 mm. to 1 mm. of lead, or 0·05 to 0·5 of platinum. Even entirely subcutaneous growths rapidly disappear after external treatment when the higher filtration is used. The technique in these cases requires much experience and careful management, the general rule being to go slowly and wait a long time for results, as the cases continue to improve for six months or a year after the treatments.

*Lymphangioma.*—This rare disease is also favourably influenced by irradiation. Under this heading we might include the rare cases of congenital lymphatic hypertrophy of the tongue.

Here again the β rays will be useful ; but a filter of at least 0·5 mm. of platinum will be required, as these growths are generally extensive and infiltrating. The same treatment is used in the congenital lymphatic hypertrophies.

*Keloid.*—This tumour responds both to radium and *x* rays, but it is more refractory than angioma or papilloma, so that care must be taken not to push the treatment far enough to obtain telangiectases.

Either β or γ rays may be used. I usually employ a filter of 0·5 mm. of platinum.

*Fibromyoma of the Uterus.*—In recent years much has been written about the treatment of this condition with rays, and it has come to be recognized that a patient over 38 should often be allowed the option between this and operation, while in some cases ray treatment will be preferred. In younger patients irradiation is not so certain in its results or so free from after-effects.

Penetrating radium rays may be used by inserting tubes with a 2-mm. platinum filter in the uterus. This method usually acts more quickly than *x* rays, but it necessitates dilatation of the cervix, which is best done by dilators under an anæsthetic ; a tent may be used, but is not recommended. *X* rays filtered through at least 3½ mm. of aluminium may be applied externally, as described later.

In most of the other benign mesoblastic growths radiations have little or no effect.

*Papilloma*, including *Warts* and *Corns.*—These are very amenable to treatment by radium, and, to a lesser degree, by *x* rays. Gonorrhœal warts are included in this series. The absence of scarring in this group of cases is often very striking.

For papillomata radium is best, with a filter of 0·5 mm. platinum or its equivalent. If radium is not available, *x* rays are a fairly satisfactory substitute, filtered rays being used in full doses.

*Exophthalmic Goitre.*—Success is obtained in so large a proportion of these cases that irradiation has come to be regarded as the treatment of choice. Great care must be taken, when using *x* rays or external applications of radium, not to give full doses, otherwise telangiectases will result ; and, unless the case is a desperate one, it is hardly justifiable to produce them. Burying radium avoids this.

Treated externally there seems little advantage in the use of radium over *x* rays, except the fact that a larger dose of rays can be given without the subsequent development of telangiectases. If the patient's condition permits of burial of radium tubes in the thyroid, this is undoubtedly the treatment to be administered. Insufficient data are available to indicate the most suitable filter. From *x*-ray treatment successful results have been obtained with a 2-mm. aluminium filter, but 3·5 mm. is better.

*Parenchymatous Goitre.*—Some of these tumours can be markedly diminished by radium treatment, but they are rather refractory. Radium should be used, tubes being buried in the thyroid for preference.

3. **When, and by what Method, the Radiations should be Applied.**—In benign growths the stage of the disease is not so important usually as in malignant growths. Exophthalmic goitre is perhaps an exception when it is severe. Naturally it is better to

treat even a benign growth while it is small, though it does not lose its reaction to irradiation in the way that malignant growths do. In cases of nævus, the younger the child the more striking is the response to treatment.

The chief objection to irradiating *fibromyoma* in patients under 38 is that in rare instances cases of atrophy of the genitalia with kraurosis vulvæ have occurred in young people who have been treated in this way. Degenerating fibroids should not be treated, nor any case of fibromyoma in which there is a foul discharge. The radium tubes are inserted into the uterus and cervix (Chéron laid stress on the latter), and 150 to 200 mgrm. with a 2-mm. platinum filter applied for twenty-four hours is quite suitable. *X* rays will be used when the growth is very large or when radium is not available ; they may also be employed in addition to radium. The first period, after the treatment by either radium or *x* rays, is liable to be excessive, especially with *x* rays ; with radium it is exceptional. Treatment is applied from the outside, over the lower abdomen from the front, and over the sacrum behind. The direction of each cone of rays is so arranged that it takes in the uterus, the ovaries, and their appendages, the rays of each cone crossing. The complicated and finicking Freiburg technique, where a large number of small ports of entry are used, is quite unnecessary, and three or four ports of entry are sufficient. We find in these cases that if we give the whole treatment on one day, much irradiation sickness follows, but this can be avoided by spreading the treatment over from three to five days.

The best time to carry out the treatment is in the week preceding the menstrual period ; but this is not essential, and the treatment should be continued should the period commence during its course. Each series of treatments is repeated once a month, and the number required varies from three to six when full doses are used.

*Angioma* can be treated either by plaques of radium or by tubes arranged in the form of a plaque.

In all these tumours except the goitres full doses are used. In the goitres the patient is often not ill enough to disregard the effect of subsequent telangiectases, so that the doses must be kept down a little and the treatment not be prolonged over too long a time. In dangerous cases this is of course disregarded. Burying radium tubes in the thyroid avoids telangiectases.

I have attempted to show that the time has come when many surgeons must revise their opinions about some forms of malignant disease, and must abandon the hopeless attitude they so often adopt when the knife will no longer serve them. It is by no means the only weapon we possess with which to combat these conditions. In addition to the cases which are left to the radiologist entirely, there will be those in which prophylactic radiation is employed, and this will often save the surgeon from the eternal dread of recurrences. It will also, fortunately, reduce the number of recurrences sent to the radiologist for relief, which now hamper the work of his department.

In conclusion, I would urge most strongly that *inoperable* is no longer synonymous with *incurable*.

# THE LYMPHATICS OF THE TONGUE: WITH PARTICULAR REFERENCE TO THE REMOVAL OF LYMPHATIC GLANDS IN CANCER OF THE TONGUE.

By J. KAY JAMIESON and J. F. DOBSON, Leeds.

The lymph glands of the neck which receive direct vessels from the tongue are: (1) *Submental glands*; (2) *Submaxillary glands*; (3) *Deep cervical glands.*

1. **The Submental Group.**—These glands lie in the triangle between the anterior bellies of the digastric muscles, usually midway between the jaw and the hyoid bone. They may be met with near the hyoid bone or under cover of the inner edge of the digastric. Usually they are three or four in number, though occasionally they are absent altogether. They receive vessels from the tip and frænum of the tongue.

2. **The Submaxillary Glands** lie between the submaxillary salivary gland and the lower border of the jaw. There are usually three: one at the anterior extremity of the salivary gland, and one in front of and one behind the facial artery as it reaches the bone. Other inconstant and small glands may be met with under or at the lower border of the salivary gland.

Our observations are in agreement with the description given by Stahr,[1] and we have not seen the profusion of glands described by some other writers.

3. **Deep Cervical Glands.**—The glands indicated by this term lie in loose tissue of the neck in general association with the great vessels. The majority are under the sternomastoid, but the obliquity of this muscle partly exposes the lower glands above the clavicle. This fact, together with a marked but irregular deficiency in the number of glands about the level of the thyroid cartilage, has led to a division into (*a*) upper deep cervical glands, and (*b*) lower deep cervical or supraclavicular glands.

*The upper deep cervical glands* have a wide irregular distribution from the level of the tip of the mastoid process to near the tendon of the omohyoid, and are mainly under cover of the sternomastoid. Some are in close contact with the front and outer side of the carotid sheath; several of these project at the posterior border of the sternomastoid, and have been called glandulæ concatenatæ; and some glands stray further backwards into the fatty tissue of the posterior triangle. Examined from in front, certain members are particularly conspicuous in specimens injected from the tongue, and merit special mention: these are a large gland and a variable number of smaller nodes lying in a triangle formed by the posterior belly of the digastric, common facial vein, and internal jugular vein. These may be called the jugulodigastric glands: the largest member, so named by Leaf, projects at the anterior border of the sternomastoid below the angle of the jaw, and is easily palpable in many living subjects.

*The lower deep cervical glands* lie in the lower part of the posterior triangle, and extend inwards under the lower part of the sternomastoid, in close relationship with the subclavian vessels, brachial plexus, and posterior belly of the omohyoid. The innermost members are under the sternomastoid in relation with the central tendon of the omohyoid; and one gland, conspicuous in our injected specimens, situated on or just above the omohyoid, frequently presents at the anterior border of the sternomastoid. It might well be regarded as a low member of the upper deep cervical glands, but, as any vessel which reaches this gland but fails to enter it must pass on to some gland of the lower deep group, we prefer to include it in this group. From its connection with all parts of the tongue we have to refer to it frequently, and suggest the name jugulo-omohyoid gland.

The superficial cervical glands which lie around the external jugular vein behind the angle of the jaw, and the glands about and below the parotid gland, were examined in every specimen, but no injection was ever traced to them from the tongue.

### The Lymphatic Plexus of the Tongue.

The plexus in the mucous membrane is continuous over the whole surface, and also with the intramuscular plexus. Behind the circumvallate papillæ the plexus is coarse, and the collecting vessels run towards the hyoid bone. In front of these papillæ the

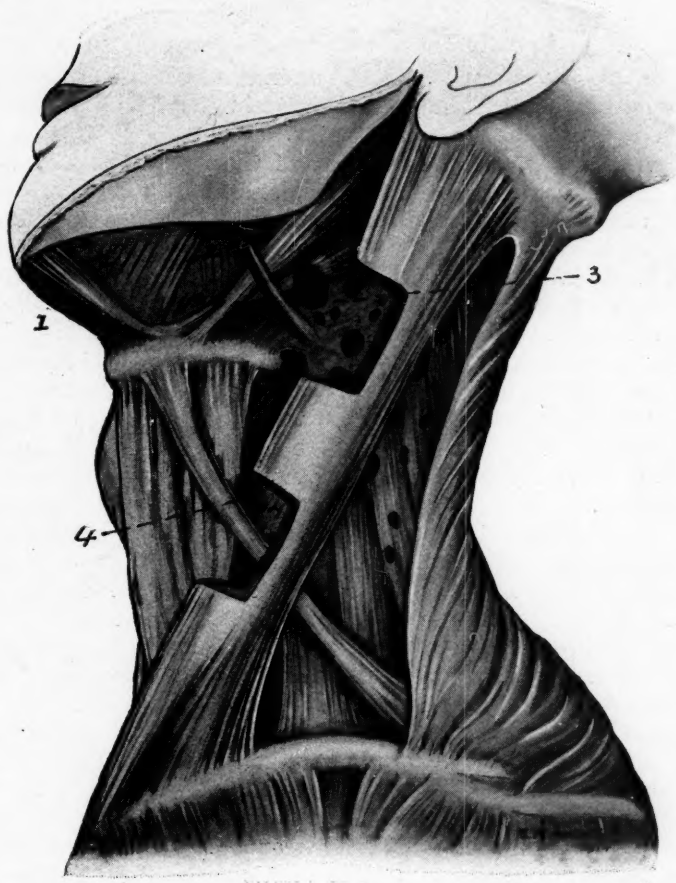


FIG. 38.—General view of glands of neck associated with the tongue. 1. Submental. 2. Submaxillary. 3. Jugulodigastric. 4. Jugulo-omohyoid.

plexus drains into two sets of vessels. One set (marginal vessels) descends from the edge of the tongue, draining the outer third of the upper surface, the margin, and the under surface; the other set (central vessels) drains the remaining part of the upper surface, most of the vessels descending in the middle line between the genioglossi; some few vessels descend in the muscular substance of the tongue, and may join either the marginal or the central vessels.

### Course of the Collecting Vessels.

1. *Marginal Vessels.*—The vessels from the tip and region of the frænum descend under the mucous membrane. In glandular termination their distribution is very wide:—

*a.* Vessels perforate the origin of the mylohyoid muscle in close contact with the periosteum of the jaw; one or more enter the submental glands, another descends over the hyoid bone, runs along the anterior belly of the omohyoid, and ends in the jugulo-omohyoid gland. It is very important to note that a vessel may arise in the plexus of one side, cross the middle line under the frænum, and end in glands of the opposite side. It is also interesting to note that the median-placed submental glands send their efferent vessels impartially to either side.

*b.* Some vessels turn outwards over the sublingual salivary gland, pierce the mylohyoid at its origin, and enter a submaxillary gland, usually the most anterior, but sometimes one or other of those associated with the facial artery.

*c.* Some vessels pass deeply under the sublingual gland and accompany the ranine vein, ending in the jugulodigastric glands, and perhaps also one of the deep cervical glands below these.

*d.* A vessel having the same course as (*c*) often turns down over or under the central tendon of the digastric to reach the jugulo-omohyoid gland, which accordingly may be injected from the region of the tip by two paths.

Some of the vessels of the lateral margin of the tongue pass outwards over the sublingual gland, pierce the mylohyoid muscle, and end in the submaxillary glands. Others run under the salivary gland with the lingual vessels and end in the jugulodigastric gland or its neighbours, and in the jugulo-omohyoid gland. The vessels from the posterior part of the margin make their way through the pharyngeal wall with the dorsalis linguæ vessels or the glossopharyngeal nerve to the jugulodigastric gland, and to reach it may run on either side of the external carotid artery.

2. *Central Vessels.*—There is no clear line of demarcation between areas on the surface of the tongue draining into the marginal or into the central vessels. Whenever injection from a puncture at the edge of the tongue extends a third of the distance between the margin and the median raphe, some central vessels will be found injected. It may be that this occurs by means of the vessels descending through the muscular substance of the tongue.

The central vessels descend in the middle line between the geniohyoglossi muscles; some turn outwards through the substance of the muscle, but the majority appear between the free borders of the muscles and diverge right and left. We must lay great stress on the fact that vessels from the plexus on one side of the middle line run to either side. The vessels run out between the genioglossus and geniohyoid, follow the lingual blood-vessels, and end in the deep cervical glands, notably the jugulodigastric and jugulo-omohyoid. Some pierce the mylohyoid and enter the submaxillary glands, even the most anterior. When the upper surface of the tongue is injected, the glands of both sides are generally found to contain the coloured mass. It is not usually the case that the fluid injection has crossed the middle line in the plexus; vessels having their origin on one side of the tongue have entered glands on the other side of the neck.

3. *Dorsal Vessels.*—The vessels draining the area of the circumvallate papillæ and the surface behind them, run backwards. The vessels near the middle line may bifurcate and run to both sides. They turn outwards to join the marginal vessels, and all pierce through the pharyngeal wall, passing in front of or behind the external carotid artery to reach the jugulodigastric glands, the jugulo-omohyoid gland, and glands between these. A vessel may run down behind the hyoid bone, perforate the thyrohyoid membrane, and end in the jugulo-omohyoid gland. Probably owing to the absence of papillæ, the vessels as they run backwards on the tongue are very distinct, and it is not easy to convince oneself that they are not veins. We have, therefore, not considered any vessel to be a lymphatic unless it could be traced to a gland.

Many writers have mentioned minute glands which may be met with in the course of the lymphatic vessels, in the floor of the mouth or the deep surface of the mylohyoid. In a few cases only have we noted these minute glands.

*Secondary Vessels.*—The efferents of the submental glands run to the submaxillary and jugulo-omohyoid glands. Those of the submaxillary glands pass to the jugulo-

digastric, jugulo-omohyoid, and glands between. The efferents of the jugulodigastric gland and its neighbours pass to the glands on the great vessels, at and below its own level. The jugulo-omohyoid gland sends its efferents either to the jugular trunk or to the supraclavicular glands.*

### THE REMOVAL OF GLANDS IN CANCER OF THE TONGUE.

Cancer of the tongue leads to invasion of the lymphatic glands at a very early stage. Many cases, apparently cured of the local growth by an early operation, succumb to glandular disease. A higher percentage of cures will be obtained, not merely by earlier diagnosis and operation, but also by a more complete removal of the lymphatic glands.

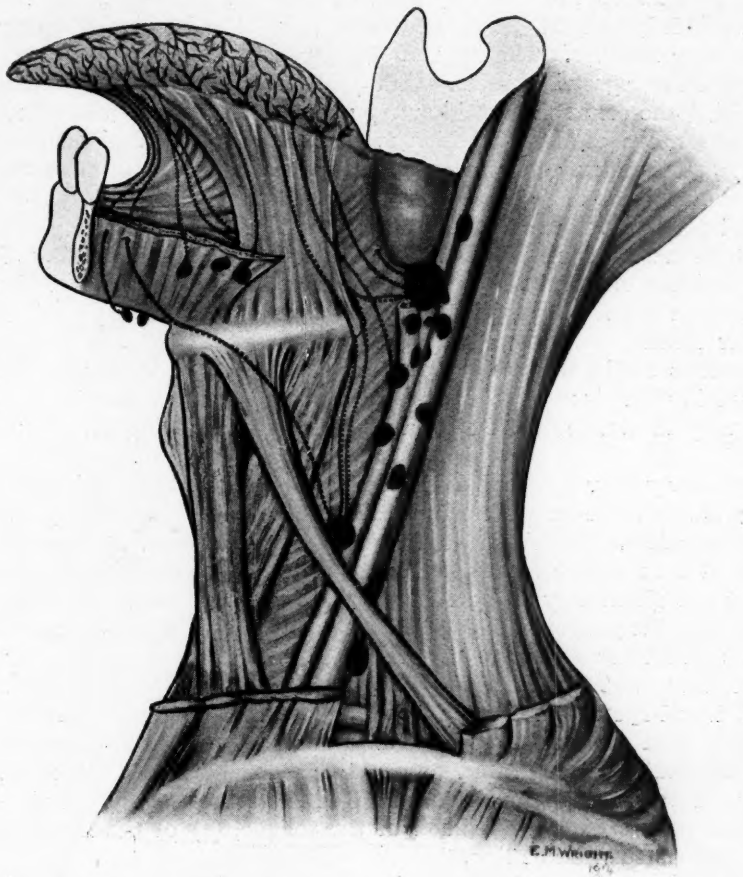

FIG. 39.—Course of vessels from tongue to the submental, submaxillary, and deep cervical glands.

We have seen that the following groups of glands receive vessels directly from the tongue: submental; submaxillary; upper deep cervical, including the jugulodigastric; lower deep cervical, with the jugulo-omohyoid.

Any or all of these gland-groups may contain diseased members in any given case of cancer of the tongue, however early. Success can only be expected if all the glands which are liable to invasion are removed in every case.

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* The anatomical statements are based on the dissection of twenty-three specimens injected by Gerota's method. Some of the specimens were adult tongues taken from the post-mortem room; others were from stillborn full-term fœtuses.

The only really adequate method of removing the lymphatic glands in cases of cancer of the tongue is that described by Crile[2] as the *block-dissection of the neck.*

Dr. Crile describes two operations, one a partial and the other a complete block-dissection. The first, which he practises in cases where the lymphatic glands are not yet enlarged, consists in removing in one piece the upper deep cervical group, the submaxillary and submental glands, and the jugulo-omohyoid gland of the lower cervical group. To facilitate this a portion of the edge of the sternomastoid muscle is excised.

The complete block-dissection consists in removing in one mass the sternomastoid muscle, the internal and external jugular veins, a considerable area of the deep fascia of the neck, and all the groups of lymphatic glands: lower and upper deep cervical, submaxillary, and submental. The dissection is done from below upwards, the sternomastoid being divided just above the clavicle, the internal and external jugular veins doubly ligatured and divided, and all the structures to be removed stripped upwards from the arteries and deeper muscles. The internal jugular vein is ligatured above, close to the posterior belly of the digastric muscle. Crile prefers to minimize hæmorrhage by temporarily compressing the common carotid artery; but this step is not at all necessary.

A great advantage of this operation is that, owing to the sacrifice of the sternomastoid muscle, all the gland-groups can be easily reached without difficult retraction and without the inconvenience of attempting to preserve the spinal accessory nerve. Excision of the internal jugular vein facilitates the removal of the upper deep cervical glands, particularly when these are enlarged. When the glands are not enlarged, it is possible to remove them satisfactorily and still preserve the internal jugular vein. This is an important point when the bilateral operation is indicated, as it is not always safe to excise both internal jugular veins.

The uppermost of the upper deep cervical glands can be more readily reached if a slice of the parotid gland is removed and if the posterior belly of the digastric is sacrificed. Part of the omohyoid muscle should also be excised while removing the lower deep cervical group.

The submaxillary salivary gland must be removed, as the lymphatic glands are closely applied to it; it must also be remembered that one of these glands may lie on the outer surface of the mandible. The submental glands vary in position. To remove them satisfactorily it is wise to take the anterior belly of the digastric with the fascia, and to remember that one gland may lie at a low level on or below the hyoid bone.

With regard to the *partial block-dissection*, it is not known to us what is now Dr. Crile's practice, but it would not appear to be 'adequate', even in cases where there is as yet no obvious gland disease. The complete operation is to be preferred.

**Bilateral Gland-operation.**—Lymphatic vessels run to glands on both sides from the tip and frænum, from the dorsum, and from almost any point at the back of the tongue. Only from the lateral border are they confined to the same side of the neck.

The bilateral operation is therefore indicated in growths (1) of the tip and frænum, (2) of the dorsal surface, (3) of the back of the tongue, (4) of the lateral border which have spread towards the middle line.

When the process of permeation of the lymphatic plexuses around a lateral border growth has extended some distance over the dorsum, cancerous emboli, if detached, may pass into the central vessels running deeply in the substance of the tongue between the geniohyoglossi muscles. These vessels run to glands on both sides of the neck. When permeation of the lymphatic plexuses around such a growth is at all advanced, it is possible that a reversal of the normal direction of the lymphatic stream may occur. In such case the glands on the other side of the neck are easily involved.

Taking all the aforementioned facts into consideration, it is evident that a unilateral gland operation is adequate only in those cases where the growth is limited to the lateral border of the tongue, and has not extended forwards or backwards or on to the upper surface to any extent. We have had experience of cases where the patient has refused the bilateral operation, and in every instance disease has appeared in the glands of the opposite side.

**The Removal of Lymphatic Vessels between the Tongue and the Glands.**—It has been taught that an operation for cancer cannot be considered adequate unless the primary growth, with a sufficient margin of healthy tissue, the lymphatic glands, and the intervening lymphatic vessels, are removed in one piece. Attempts are made to operate on these lines in cases of cancer of the breast, colon, penis, and other organs, and of late years operations founded on this principle have been practised for cancer of the tongue.

Probably all surgeons will agree that, at the present time, the preliminary removal of the tongue, with a gland operation at a later date, is infinitely safer than any of those operations which are devised for removing the tongue with the lymphatic glands and the

FIG. 40.—Distribution of vessels from the postcircumvallate area of the tongue to the deep cervical glands. Note vessels perforating pharyngeal wall below tonsil, some winding behind the carotid vessels.

intervening tissues in one mass. The argument used against the operation in two stages is that the lymphatic vessels, between the growth and the glands which are not removed, may contain cancer cells. The whole question depends on the method by which the lymphatic glands are invaded, by embolism, or by the gradual growth of columns of cancer cells along the vessels—permeation. If the glands are involved as a result of permeation of the large vessels, i.e., if columns of cancer cells grow along these vessels to the glands and then give rise to gland disease when, and not until, they reach the glands, then it follows that in every case in which disease can be demonstrated in a given gland there must be cancer cells in a lymphatic vessel or vessels running to it. This cannot be demonstrated. Further, if the glands are invaded as a result of permeation of the large

lymphatic vessels, no case with gland disease, however early, could be expected to be cured by such an operation as Butlin[3] commonly practised, viz., intrabuccal excision with subsequent gland dissection, for in all such cases permeated lymphatic vessels must have been left behind. Still, Butlin was able to say that " out of 70 cases in which the anterior triangle was completely cleared out, and a number of cases in which glands were simply dissected out because they were enlarged, I have very rarely removed the primary disease and the glands in one continuous mass. Yet 29 of these cases proved to be successful."

Sir George Lenthal Cheatle's work[4] on the spread of cancer of the tongue is of the greatest importance. He has shown that the deeper muscles of the tongue are much more widely affected than was generally thought. This invasion appears to be the result of permeation of the lymphatic plexuses of the muscles of the tongue. But he does not show

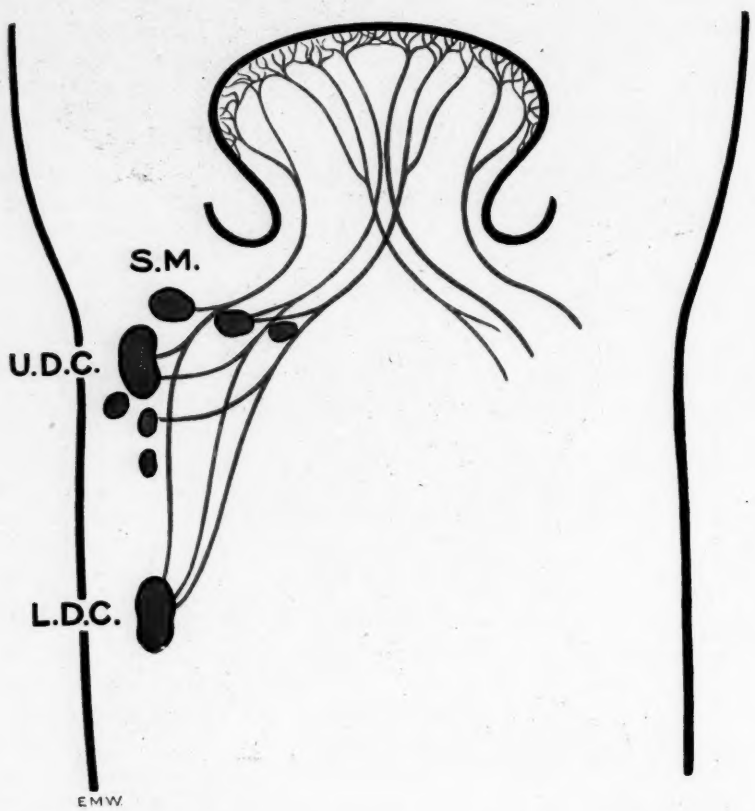


FIG. 41.—Diagram to show course of the central lymphatic vessels of the tongue to glands on both sides. **S.M.** Submaxillary glands. **U.D.C.** Upper deep cervical glands. **L.D.C.** Lower deep cervical glands.

that the larger vessels are permeated. It seems that, while the lymphatic plexuses and smaller vessels within the tongue are permeated, the large vessels running from the tongue to the glands are not, except perhaps very late in the course of the disease, and that gland invasion is the result of embolism. The removal of the large intervening lymphatic vessels does not appear to be necessary; but even if it were it is not practicable.

We need only recapitulate the course of the larger lymph-vessels running from the tongue to the glands. From the tip of the tongue and frænum they run, as we have said, close to the periosteum of the jaw and through the mylohyoid, and also above and below the hyoglossus muscle with the lingual vessels and hypoglossal nerve. From the lateral border they run over and under the sublingual gland with the blood-vessels. The central vessels on their way to the glands have a similar course. From the posterior part of

the margin, and from the back of the tongue, vessels pierce the pharyngeal wall and run on either side of the external carotid artery.

It is obvious that if it were necessary it is really impracticable to remove all the lymphatic vessels intervening between a growth of the tongue and the invaded glands. It is unlikely that the high recurrence-rate after operation for cancer of the tongue is due to leaving this intervening tissue. It is due, on the one hand, to incomplete removal of the primary growth—to leaving the deeper muscles of the tongue, which Lenthal Cheatle has shown to be extensively invaded—and on the other, to imperfect gland operations.

It is probable that in early growths an intrabuccal operation will suffice if care be taken to cut the tongue off close to the hyoid bone; but in the later cases an extrabuccal operation is essential.

We may conclude by stating what methods of operation appear to be 'adequate' in cancer of the tongue, in view of the lymphatic distribution we have described.

In early growths of the lateral border of the tongue, a unilateral *complete block-dissection of the neck* with intrabuccal excision of half the tongue, at one sitting, is indicated. This operation is quite satisfactory and not unduly dangerous. If, however, the patient is not in good condition, the intrabuccal operation may be done first and the gland operation at a later date.

In quite early small growths of the tip and frænum, or on the dorsum of the tongue, a *unilateral block-dissection* with intrabuccal excision of the tongue at one sitting, followed by a block-dissection of the other side of the neck at a later date, is required. The internal jugular vein should be preserved during the second block-dissection.

In more advanced growths of the lateral border, tip and frænum, and dorsum, and in all growths at the back of the tongue, an extrabuccal operation (Syme, or some modification) is essential, as is also a *bilateral block-dissection of the neck*, preserving the internal jugular vein on one side. This is impossible at one sitting, highly dangerous even at two, and only to be done with any degree of safety at three sittings. It is difficult to induce patients to submit to a three-stage operation.

In cases where the growth has spread from the tongue to the floor of the mouth, jaw, or tonsil, nothing less than a *bilateral block-dissection* of the lymphatic glands will be 'adequate', whatever be the nature of the operation on the primary disease.

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[3] Butlin, *Burghard's System of Operative Surgery*, ii, 244 & 247.
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# ON THE TECHNIQUE OF RE-AMPUTATION.

By ALAN H. TODD, London.

Though most of the men who suffered amputation in the War have now been fitted with good artificial limbs, quite a considerable number of pensioners are still to be seen who, for one reason or another, cannot be fitted with a limb, or will not wear the one they have. The object of this paper is to show which of these cases would be benefited by re-amputation, and to set forth the technique which, in the writer's experience, has appeared to give the greatest proportion of successes. Moreover, the time is not far off when artificial limbs will be standardized to some extent, as regards design, and it is therefore of great importance that some uniformity should be adopted, if possible, as regards the fashioning of amputation stumps.

The main desiderata in a stump are that it should be: (1) *Useful*; (2) *Of suitable length*; (3) *Of suitable form*; (4) *Painless*; (5) *Well covered*; and (6) *Well nourished.* Let us consider these points in detail.

It does not follow that the greatest length that can be retained in a limb is necessarily the most useful. For instance, in amputation through the leg, there is nothing to be gained by amputating through the lower third instead of at the junction of the middle and lower thirds; the extra length of bone does not confer any greater stability upon the wearer of an artificial limb, or any better movement of the joints, whilst it often gives rise to trouble through insufficient covering. Again, disarticulation through the elbow or the knee is not so good as amputation rather higher up, because it is impossible to make an artificial joint at the same level as its fellow, quite apart from the fact that the stump is bulbous and difficult to fit.

On the other hand, it is most important that a sufficient length of stump should be preserved to afford proper leverage and control of the joint above. With the limbs that are in common use to-day, it has been found that an arm stump must be 10 cm. long, a forearm stump 10 cm. long, and a thigh stump 12 to 14 cm. long, if a useful amount of flexion is to be retained at the joint above. If the limb is unusually bulky, so that the prosthetic appliance does not grip the bone as firmly as usual, these amounts must be increased somewhat. In certain cases, a very short stump below a joint is actually detrimental, and is better sacrificed. At the shoulder, for example, an inch or so of humerus is quite useless, and prevents the application of a decent-looking limb. The same remark applies to short lengths of the upper part of the femur. Again, many surgeons, though not all, consider that nothing is gained by preserving an inch or so of the upper end of the tibia, or the astragalus and ankle-joint; they argue that to have a joint that is practically uncontrollable at such a short distance from the end of a stump is a source of instability, and is therefore disadvantageous. With this view I, personally, concur.

The question of length is controlled to some extent, moreover, by the condition of the joints above. (This is a point that has often been overlooked, judging by what one sees at the Appeal Boards of the Ministry of Pensions.) For example, if a man has a perfectly stiff knee, he does not gain very much by having four inches of tibia preserved; he would be better off with an amputation higher up and a good modern limb with a controllable balanced knee-joint. As regards length, then, we must be guided, not by rule-of-thumb alone, but mainly by a common-sense consideration of the functional value of the part that we are thinking of preserving.

As regards *form*, one may make a generalization, and say that the best shape, from the point of view of the instrument-maker, is that of a gently-converging cone—after the shape of a medicine-bottle cork. Such a stump always fits snugly into the bucket, and

also affords a wide surface over which pressure and weight-bearing may be distributed; the limb can be made of neat shape, and provision is easily made for 'taking up the slack' if any wasting occurs. Furthermore, the grip is so good that end-bearing is never necessary, which is a great advantage if the end of the bone is unfortunately rather tender and yet it is very desirable that no more bone should be removed. (This condition may obtain, for example, when the length of stump is already nearing the functional minimum laid down above, and perhaps the other limb has been amputated at an even higher level.)

*Pain in a stump* may be due to a variety of physical causes, apart from pain of purely subjective origin, with which we are not now concerned. Pain due to the formation of fibroneuromata has long been recognized; it is generally of a toothache-like character, but is invariably associated, as far as my experience goes, with marked local tenderness at the site of the neuromata; pressure there gives rise to an intense darting pain, of a neuralgic kind, which is stated either to shoot up the limb, or else to travel to the periphery of the part that is lost. In other cases we meet with quite small areas, or even points, in the flaps, which are acutely tender; it is assumed that these are due to small nerve filaments being caught up in scar tissue, and apparently the supposition is correct, for the undercutting or excision of the scar relieves the pain for the time being. This, however, is a bad method of treatment, for the nerve fibres soon grow down again, and the pain recurs. In many stumps tenderness is due to inflammatory trouble in connection with the bone itself; there may be chronic periosteomyelitis going on there, which results simply in the characteristic deeply-seated boring kind of pain; or perhaps bone proliferation is taking place, and spikes of bone are forming, which jut out into the surrounding muscles and other tissues, and naturally cause pain there. In yet other cases the inflammation of the bone is rather more active in type, and a skiagram will show that a sequestrum is separating, or that there is a considerable thickening about the bone, in which, presumably, some septic matter is pent up.

Generally speaking, the bone in an amputation stump shows marked rarefaction and absorption under the *x* rays; but I have seen one or two cases in which the patients complained of nothing but an inveterate aching, and no cause could be discovered except marked thickening and sclerosis of the bone. Presumably these were cases in which the irritation set up by the sepsis was just enough to stimulate osteogenesis, but not enough to cause absorption or necrosis. Acting on the analogy of Brodie's abscess, I drilled the bone for two of these patients, using a $\frac{1}{8}$-inch drill, and making perhaps a dozen holes or more; this at once relieved the pain, which had been constant for over two years. Whether the effect will be lasting remains to be seen; presumably the drill-holes will eventually fill up with bone; but one supposes that as long as there is tension within the bone, exudation will take place, and this will keep the holes open, and also lower the vitality of any organisms that may be smouldering within. In other words, one is really treating the pain by draining the sclerosed bone into the soft parts around. The sepsis is of such a mild order that no harm ensues.

Lastly, there is a class of case in which the whole stump appears to be more or less tender. Everyone has seen these cases in abundance during the War, and even in the civil surgery of the days before the War they were not unheard of; yet no one seems to have described them separately, or tried to reason out their pathology, and the logical treatment that should ensue. In such cases sepsis has always been a prominent feature: that, no doubt, explains why they were more common in the early days of the War than towards its conclusion, and why they are less common in civil than in military surgery. Yet they are quite common amongst civil cases in which considerable suppuration has occurred, as, for example, after accidents and compound injuries.

The tissues of the stump, in these cases, are almost always of a more or less indurated, rubber-like consistence; they often feel tough and tense, and are more or less matted together, so that it is impossible to distinguish the skin, fat, and muscles by palpation, and to move them over one another; there is just one tough, resilient whole.

An analogous condition is to be seen in the ordinary stump that results after laceration of the fingers; very often the whole finger becomes tough and ill-nourished, and very

tender, so that the patient is unable for months afterwards to use it for any manual work. Sometimes there are individual tender spots, sometimes the whole thing is uniformly tender and useless. If one excises the tender spots in the skin, the result is invariably disappointing; but if an inch or more of the cutaneous nerve of the part is removed, the result is better, and the pain is relieved for some time; but eventually it recurs in many cases, and in a large proportion a small fibroneuroma forms upon the cut end, higher up. In fingers that show general tenderness, no operative treatment is of the slightest use; it only stirs up trouble and makes matters worse. The only hope is to amputate the finger through healthy tissues, or else to leave it alone until the pain disappears, which it generally does, in course of time.

A moment's reflection will show that these two types of case, the generally-tender finger and the generally-tender stump of a limb, have this much in common, that they are invariably the outcome of a septic lesion. They are never seen in cases which have run an aseptic course. The same holds good of fibroneuromata, in my experience; they are extremely rare in aseptic cases, whilst they are common where there has been prolonged suppuration. Having watched a number of cases of ordinary lacerated finger very carefully, and operated (more or less unsuccessfully) in some of them, I came to the conclusion, some years ago, that fibroneuromata were to be regarded in these cases as being essentially irritative and septic in origin. Apart from the etiological fact that they only occur in septic cases, there is some pathological evidence for this view, in that the nerves are always seen at operation to be swollen, red, and congested; under the microscope they show all the ordinary changes of chronic neuritis.

When the War came, a number of observers soon demonstrated that microscopical evidence of inflammation was to be found at a considerable distance from the track of the missile, in almost all cases; at a late date, in fact, the tissues are absolutely permeated with round cells and other inflammatory formations. Professor Marinesco, working with Edred Corner, demonstrated that foreign bodies or bacteria were to be found in fibroneuromata in almost all cases, and that not only the nerves themselves, but the surrounding tissues also, were densely infiltrated with inflammatory material. Still later, it was shown by Corner that the nerve filaments were by no means confined to the recognized anatomical nerve paths, but were often found to have wandered off along new paths of their own. Sometimes they followed the path of an adjacent blood-vessel; sometimes they tracked along a tendon or any other convenient structure; sometimes they wandered aimlessly through the tissues, not following any particular path. This supports what has already been noticed in the case of septic fingers; it was not the nerves only that caused the tenderness, or that were inflamed; it was the whole stump; and to deal with the nerves alone was disappointing, because numerous filaments would be left behind, that were irritated by a chronic inflammatory process going on in and around them. In other words, *the tenderness and pain in many amputation stumps (whether of limbs or of fingers) is caused by a generalized inflammatory condition of all the tissues of which it is composed, and not of the nerves or nerve-endings only.*

This has a most important bearing on treatment; indeed, it supplies the clue to the successful treatment of these cases. It is obvious that the inflammation will be most acute around the tissue that has been the most severely and persistently infected; as a rule this will be the bone, for though the soft parts may be the last to heal, yet it is in the bone that organisms are most liable to lie latent. In the soft parts, organisms are not liable to persist for long, except, perhaps, in masses of avascular scar-tissue. It may be laid down as an axiom that *no operation for the relief of pain or tenderness in an amputation stump will be wholly successful, if a zone of latent sepsis is entered in the process.*

Nor will success be attained if there is the least tension in the *coverings* of the stump. Many amputations were performed during the War in which the flaps were cut much too short. In compound fractures, and especially in those military fractures which are produced by high-velocity missiles, the ordinary civil rule (that the combined length of the flaps shall equal one and a half times the diameter of the limb at the level of bone-section) is altogether inapplicable. Very often there is considerable suppuration, and whilst this

is being overcome the flaps shrink and retract greatly. The muscles are damaged, if not actually devitalized, over a considerable distance from the initial wound, and during the healing process all this area becomes permeated with inflammatory products, much of which becomes altered into connective tissue, which slowly but inevitably contracts, like all young scar-tissue in every part of the body. Again, after severe injuries the muscles are thrown into a state of violent spasm, and are much more excitable than normal muscles; there is consequently an abnormal tendency to retraction of the flaps. It cannot be emphasized too strongly that the commonest mistake of inexperienced operators in cases of compound fracture is that of cutting their flaps much too short; they should always be capable of covering the bone without the slightest tension, and a moderate excess is not detrimental in any way. To turn back short flaps, with the idea that they can be brought down after the suppuration has been cured, is futile; they always retract and become so fibrosed that this is practically impossible. In thoroughly septic cases it is far better to amputate as low down as possible in the first instance by the flapless method, get rid of all infection, and then re-amputate later at a higher level through normal or comparatively normal tissues. By using the flapless method, the sepsis is reduced to the minimum, and is localized to the tissues immediately adjacent to the cut surface; consequently, the re-amputation always follows a course that is clinically aseptic, and the result is correspondingly good; the covering of the stump is ample, and there is no tenderness. If, on the other hand, the surgeon tries to fashion elaborate flaps at the outset, infection will often be prolonged and widespread; the tissues may become impregnated with it, and, when re-amputation becomes necessary, fresh inflammation is set up, sinuses may form, and even fresh necrosis of the bone may occur. Thus, in course of time, a third operation becomes necessary, with a correspondingly bad result, quite apart from the loss of time and money, the disappointment of the patient, and the pain to which he is subjected. I have seen cases in which, through failure to appreciate the importance of performing the final amputation through clean tissues, the operation has been repeated as many as five times. I am strongly of opinion that, whenever we decide that a patient must undergo re-amputation, we should design our operation, if possible, so that he ends with a stump that has all the characteristics of a good civil amputation that has run an aseptic course. The scar should be thin, linear, and non-adherent; there should be no thickenings in it at the site of former sinuses, and the coverings of the stump should be ample, supple, and not infiltrated with old inflammatory products.

When it was found that the flaps were of insufficient length, attempts were often made to drag them down by means of weights or of elastic traction. This is a perfectly futile proceeding. I have no wish to disparage the use of traction in preventing undue contraction in flaps that are of proper length; in view of what has been said already about the marked tendency to spasmodic shortening in these cases, this is clearly a very wise and necessary proceeding; but to attempt to convert short flaps into satisfactory ones by this means is useless. One may possibly succeed in dragging the flaps down to a certain degree, and then getting granulation tissue to grow over the remainder of the stump: perhaps skin-grafting will be employed for this purpose, or to expedite healing; but I have never seen a stump made in this way that could be called really satisfactory. When there is sufficient length of stump, it is far better to re-amputate higher up; when there is not, it is wiser to provide a thoroughly good and ample covering for the end of the bone by means of a pedicled flap from some other part of the body. For example, I had under my care a lad who had suffered amputation through the right forearm four inches below the tip of the olecranon: the movements of the elbow-joint and superior radio-ulnar joints were perfect, but he had a badly-covered stump, for the ends of the radius and ulna were almost protruding through a thin scar, which had been made by skin-grafting a scanty bed of granulation-tissue, after dragging down two very short flaps. He could not wear an artificial arm. If I had removed more bone, the power of controlling his elbow and his voluntary pronation and supination would have been lost. I therefore excised the unsatisfactory covering, and grafted a cup-like covering of skin and subcutaneous fat by means of a pedicled flap of tissue from the anterior abdominal wall. The result

was most satisfactory. The same technique can be applied to leg stumps from which no more bone can be spared: and here it is even more important to give a good covering than in the case of the arm; for in the arm, the artificial limb tends rather to fall away from the stump, whereas in the leg there is often some end-bearing, through the limb being thrust up against the stump. True, end-bearing can be avoided by making the stump of a tapering form; but it is just in cases of short stump that we require all the bearing we can get.

Let us now review the various factors that we have considered as bearing upon the technique of re-amputation. In the first place, we shall always have to consider whether any more tissue can be spared, having regard to the ultimate functional value of the limb; if it can, re-amputation must be considered; if it cannot, pedicled grafting may be advisable in those cases in which the disability consists entirely in faulty coverings. Next, we have seen that tenderness or pain in a stump is by no means always attributable to the nerves, or to neuromata, or to nerve-filaments incarcerated in the cutaneous scar; very often there are other structures involved as well, or the whole stump is tender on account of a low-grade inflammatory condition. To cut into such an inflamed zone, or even a zone of latent sepsis, is unjustifiable: such a proceeding often stirs up trouble, and never relieves it. It is clearly far better to try to deal radically with all the possible sources of pain in one comprehensive operation, and not to tinker with any one of them.

The logical outcome of all these considerations is that one should try to make a block-dissection of all the pathological tissues involved, and at the same time fashion a stump of appropriate shape and length. To be more precise, one should not dissect at all; dissection merely means opening up numerous new planes to possible infection, with consequent delay in healing, and spoiling of the result. We should aim, rather, at *block-excision* of the damaged tissues. Such a method is simplicity itself in actual practice. Instead of trying to unearth tissues that are more or less unrecognizable, and to make artificial separations between them, one divides the tissues *en masse*. Even the main arteries of the limb can be safely divided in a block-excision of this kind, for when some time has elapsed since the primary amputation, they are always so small that the loss of blood consequent upon division is quite unimportant.

## DETAILS OF THE OPERATIVE TECHNIQUE.

The technique can now be discussed. Let us suppose that the case is an ordinary one of more or less pointed thigh stump, in which the bone is inclined to protrude, the cutaneous scar is rather thick and irregular, the muscles towards the end of the stump are stretched and fibrotic, and there have been several sinuses at some preceding time. Also, as likely as not, there will be some chronic osteitis about the end of the femur.

A tourniquet may or may not be used: the loss of blood is not considerable when it is not used, and its use involves two disadvantages: (1) It is uncomfortably near the site of operation, and restricts the movement of the soft parts by binding them tightly down; (2) It prevents one seeing at the time of operation which tissues are plentifully supplied with blood, and which consist of more or less bloodless scar-tissue. On the whole (though I prefer a tourniquet for most limb operations), it seems wiser generally to dispense with it in re-amputations.

The other leg being tied out of the way, the stump is held well up, and an incision made with an ordinary scalpel through the skin, as near as possible to the scar. It is useless to include scar in the flap; the incision must be through normal skin; if it is redundant, it can always be trimmed away later before sewing up. The incision is deepened through the fat and superficial fascia, the scalpel being held obliquely, so that it cuts in the direction of a point three or four inches above the end of the bone: the general idea of the operation is to excise a solid cone of stump, containing all the pathological tissues, and leaving the cut surface of the bone as the apex of the conical space left.

As soon as the deeper layer of the superficial fascia is severed, the skin will probably retract easily ; it is seldom that the natural line of cleavage at this level is lost. The skin is therefore pulled back all round the stump as forcibly as possible ; if this does not give good enough access to the stump, it must be slit longitudinally on the outer side of the thigh, and sutured accurately again afterwards ; this manœuvre always gives ample access, and does not lead to any added disability. (A scar on the inner side of the thigh is much more objectionable.) A strong-backed amputation-knife about five inches long is now taken, and a bold sweep made round the more superficial muscles, still preserving the wedge-like character of the excision ; then again, this time cutting the deeper muscles and the periosteum, right up to the calculated apex of the cone to be removed. The main vessels of the limb will be severed at this second cut, but the assistant is ready with a powerful Mayo-Ochsner artery forceps, and catches them up at once, before any blood is lost. All the soft parts are now held well out of the way, and the bone is divided cleanly by means of a Butcher's saw. As a rule, it is best to steady the stump at this stage by grasping it firmly with a large Ferguson's lion-forceps, or a small Lane's forceps. Spouting vessels are now caught up systematically with Mayo-Ochsner artery forceps, beginning with those in the upper part of the flap ; otherwise, these bleed on to the vessels below, and obscure the view. The main vessels are tied with stout catgut ; some prefer to tie them with two ligatures, placed about half an inch apart, while others like a stay-knot. In the thigh, it is perhaps well to tie the artery and vein separately, but in all other situations I have always found that the vessels were so small and atrophied that there was no reason for not tying them both with one ligature.

The main nerves are now sought and pulled down ; each one is then carefully injected with absolute alcohol or with pure methylated spirit ; 2 c.c. are used for the sciatic, and 1 c.c. for all others. Many methods of dealing with the nerve stumps in an amputation have been described, but I have not had a single case of pain from neuroma since I adopted this simple expedient six years ago. The only precaution necessary is the very simple one of making sure that the whole thickness of the nerve is permeated with the alcohol ; to do this, I plunge the hypodermic needle into the very centre of the nerve, right up to the shoulder, and inject about half the total quantity ; then I withdraw it a little, and thrust it forward in some other direction, inject a little, and repeat the process. If this is properly carried out, the whole nerve immediately becomes swollen, white, and opaque. As the anatomical result the nerve is 'fixed', and such a dense coagulum forms at the end of it that no nerve fibres can penetrate it ; but I have never had a failure to relieve pain by this method, and therefore have never had an opportunity of cutting down on a nerve afterwards and examining it. The pain caused by this proceeding is not as great as one might expect, and it is easily controlled by morphine ; it never lasts more than two days, at the outside, and the excellence of the results quite justifies the employment of the method. At one time I used first of all to block the nerve higher up, by a preliminary injection of novocain or urea-quinine-hydrochloride ; but later on I preferred to get my alcohol in as high as I could, and then shorten the main trunk below as much as possible. The arteries that have been crushed will have ceased to give trouble by this time, and the artery forceps can be taken off ; in all probability no ligatures whatever will be required, which is an advantage when working in tissues of doubtful sterility ; but if any are necessary, they will, of course, be of catgut.

No special trouble is taken as regards the periosteum ; it is simply cut off flush with the bone, and left ; no disadvantage has been seen to accrue.

If the operation has been well performed, the muscles will fall together snugly over the end of the stump without tension, and no sutures need be passed through them ; if, however, they do not set nicely, and are inclined to expose the end of the bone, it may be well to draw them loosely together with one or two interrupted sutures of catgut, which should pass through the deep fascia ensheathing the muscles as well as through the muscles themselves. Lastly, the skin, fascia, and fat are adjusted edge to edge, and any gross excess of skin is trimmed away ; any pieces that seem at all indurated or puckered are also excised, the object being to secure everywhere a thin, mobile, linear scar, with

primary union. Any part, moreover, that is tied down and cannot be spared is cautiously mobilized by undercutting. A few mattress tension-stitches of the strongest black fishing-gut are now passed through the whole thickness of the flaps, and through the superficial part only of the muscles as well; these serve to prevent retraction of the muscles, to prevent hæmatoma and dead-space inside the stump, and to take all tension off the coaptation stitches in the skin. The skin itself is sewn accurately with fine salmon-gut or well-boiled thread, and then a piece of tube about three inches long, and as thick as a lead pencil, is inserted into the space beneath the skin, through a hole at the outer angle of the wound. It is secured in place by a stitch through it, and a loose one is passed alongside it, and left long, so that it may be subsequently tied and the space healed rapidly.

Much the best dressing consists in layer after layer of plain sterile gauze bandage, applied in roller fashion from above downwards whilst an assistant pulls the soft parts of the stump strongly downwards; applied in this way, the gauze exerts firm pressure upon the stump, moulding it into good form, arresting oozing, and preventing retraction of the flaps. For a thigh stump, about three six-yard rolls of gauze should be applied, followed by a thick layer of sterile cotton-wool roll, then a sterile bandage, more wool-roll, and a second bandage; the last may be a cap or a many-tail bandage, if desired. It will be found that a dressing like this will invariably prevent oozing and actual hæmorrhage, so that hæmatoma and all its complications will be absent, and the wound will heal readily, in spite of the large and vascular area of tissue that has been exposed. After forty-eight hours the dressings are removed for the first time, and the tube is withdrawn; everything is replaced with the least possible disturbance of the coherent skin-edges, and the loose suture alongside the tube is tied. After four days the tension-stitches are taken out; if they are left longer, they may impair the vitality of the skin included within the mattress, and it may slough to some slight extent; apart from this, they are no longer necessary. At the end of ten or twelve days all the skin-stitches are removed, and the wound will be firmly healed. It is well, however, for the patient to wear a domette or crêpe bandage round his stump for some time, simply for the purpose of keeping it in good shape.

After-treatment is practically nil; it consists simply in keeping the skin-scar mobile over the deeper tissues from the very first. It will eventually become displaced from the end of the stump, and will give rise to no trouble.

## CONCLUSIONS.

1. The technique of re-amputation should be standardized.

2. The form of the stump must be determined partly by the kind of artificial limb that is afterwards to be fitted, and partly by consideration of the functional utility of the limb as a whole.

3. The tenderness is the outcome of chronic inflammation in the stump; this not only gives rise to osteitis and fibroneuroma, but also to pain in all the remaining tissues of the stump.

4. To secure a good result after a re-amputation, it is essential that the wound should follow practically an aseptic course, and the only way to ensure this is altogether to avoid cutting into a zone of sepsis or latent sepsis.

5. The best and easiest method consists in the excision of a conical piece of the end of the stump *en bloc*, without any dissection whatsoever. The cut passes through tissues which are practically normal, and heals by primary intention.

# CLINICAL AND PATHOLOGICAL ILLUSTRATIONS OF DIVERTICULITIS.

At a recent meeting of the Surgical Section of the Royal Society of Medicine (Jan. 7, 1920) a number of radiograms and specimens of diverticulitis were exhibited. Through the kindness of the secretaries of the section, Mr. Sampson Handley and Sir C. Gordon Watson, we are enabled to reproduce illustrations of most of the cases described at that meeting.

For the purposes of description the cases may be divided into four categories, viz. :— (1) *Those in which symptoms were absent or slight*; (2) *Cases of stenosis of the intestine*; (3) *Cases of perforation*; (4) *Vesicocolic fistula.*

## 1. CASES WITHOUT SYMPTOMS.

Dr. E. I. Spriggs referred to the work on diverticulitis by Drs. Telling and Gruner[1] in 1917, D. Roberts[2] in 1918, and J. W. Keefe[3] in 1917, and said that the experience gained

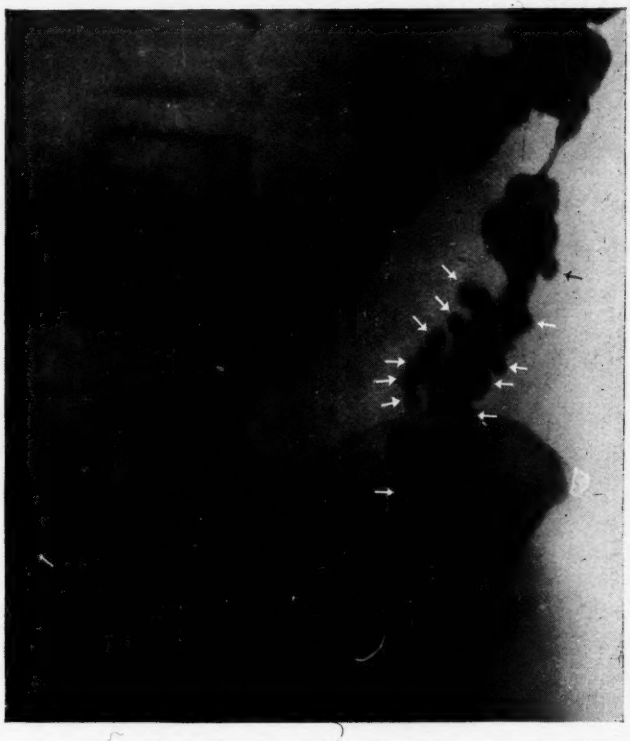


FIG. 42.—*Case* 1. Male, 57. Multiple diverticula in the descending colon. One (not in profile) was seen in the transverse colon.

FIG. 43. —*Case* 1 (the same patient as in *Fig.* 42). Posterior view of descending colon. The lumen of the bowel is empty, but opaque material remains in the diverticula. The number seen is greater than in *Fig.* 42, because some show now which were not in profile when the bowel contained opaque material.

at Duff House supported the view that multiple diverticula could be recognized easily in *x*-ray photographs of the colon, but such cases had not been found to be common. In

the *x*-ray examination of over a thousand alimentary canals, diverticula of the large intestine had been seen six times. He had excluded between two and three hundred early cases from these figures, as they had not learned at that time the importance of taking photographs freely. The proportion of cases showing diverticula was, doubtless, understated by these figures, because in some cases the descending colon and sigmoid might not be completely filled at the times of examination; and if there were no bowel symptoms the opaque meal would not be repeated, nor would an opaque enema be given. Every effort was made, however, as a matter of routine, to see the descending colon and sigmoid when filled; and as the patient was in the same building as the *x*-ray room this could usually be done.

With good plates, when the little pouches were multiple and had reached the size of a small currant, they were easily seen. Diverticula in the early stages of their formation, or diverticula which were few in number and were filled with fæces or did not come into profile, might be missed; but if there were many of them, as there generally were, it was unlikely that none would fill with barium or show on the plate. As soon as they began to retain material longer than the bowel, that is to say, as soon as they were likely to be

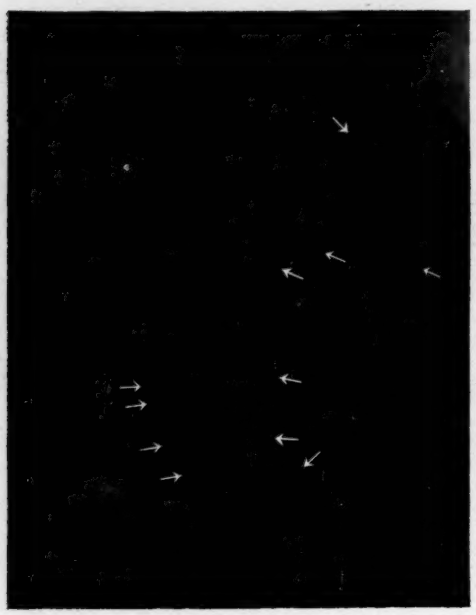


FIG. 44.—*Case* 2. Male, 67. Thirty-six hours after opaque meal. One large and some smaller diverticula in the iliac and pelvic colon.

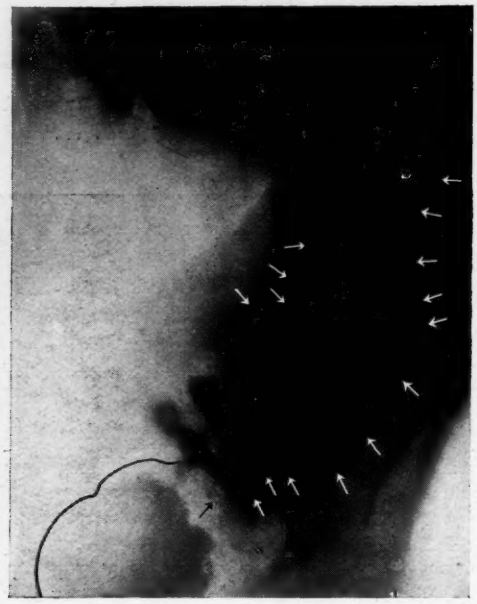


FIG. 45.—*Case* 3. Male, 71. Thirty-six hours after opaque meal. Diverticula in all parts of the colon. There was also one of the terminal ileum.

predisposed to inflammation, if at all numerous, they were obvious; for the chain of opaque dots lying along the course of the empty bowel was characteristic. All of their cases showed retention of barium in the diverticula. The accompanying illustrations (*Figs.* 42–47) are from plates by Mr. Marxer. These six cases of unsuspected diverticula of the colon were all males, of ages varying from 53 to 71. One showed a single diverticulum on the plate; in the other five the diverticula were multiple, and in three numerous. Two of them also showed one diverticulum in the terminal part of the ileum. In another there was a large single diverticulum, probably of a different nature, in the third part of the duodenum.

The diverticula of the colon are thought to be simple extrusions of the bowel wall at weak places. It is to be noted that they occur in those parts of the small and large intestine where the contraction of the muscle in the wall of the bowel may be supposed to

be especially vigorous, with a corresponding increase of pressure in the lumen, namely, in the last few inches of the ileum and the latter part of the colon. One of the patients had suffered from severe constipation, four gave a history of moderate or intermittent constipation, and one had never been constipated. In four of the six there was no *x*-ray evidence of delay in the bowel. In two there was such evidence, the opaque material not having passed through the colon in seventy-two hours. (The rate of passage of the buttermilk meal was quicker than that of some other opaque meals. With buttermilk forty-eight to seventy-two hours was regarded as a normal time.) In one case there was general hypertonus of the large bowel, and in another hypertonus of the pelvic loop.

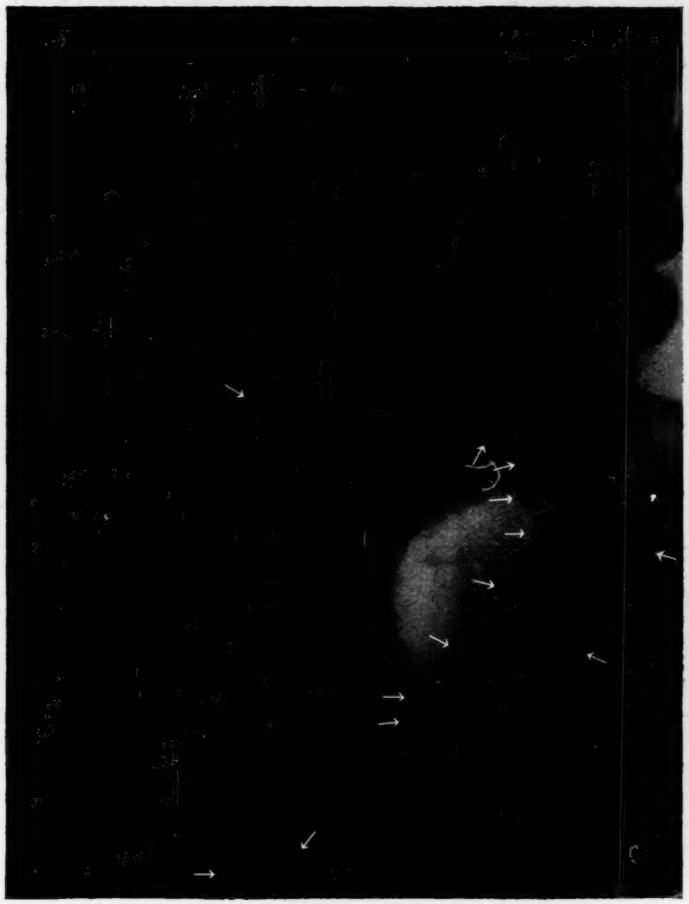


FIG. 46.—*Case* 4. Male, 53. Sixty hours after opaque meal. A diverticulum in the transverse colon, and many in the descending colon.

FIG. 47.—*Case* 6. Male, 67. Ninety-six hours after opaque meal. Multiple diverticula containing material after the lumen of the bowel is empty.

The series was small, Dr. Spriggs said, but he brought it forward, firstly, to show how well diverticula could be recognized by the *x* rays ; secondly, because it was an early series. Not one of these patients had any symptoms clearly attributable to the diverticula which were seen. Of course, in view of the risks they run, their medical advisers would be kept in touch with. In all, the diverticulum-bearing area of the bowel was freely movable. The cases included two of chronic appendicitis (one of them with arteriosclerosis), two of duodenal ulcer, one of gastric hypo-acidity, and one of neurasthenia following a chronic infection. The last-mentioned patient had not been heard of recently. The other five recovered, and four of them were following active occupations.

Mr. L. E. C. Norbury showed a portion of a colon from which project numerous small sacculi of the mucous membrane extruded between the fibres of the muscular coat. Many contain pellets of hardened fæces. The specimen (*Fig.* 48) was from a woman, age 69, who died of cancer of the stomach, liver, peritoneum, and pleura. No stricture was detected, nor any other disease whatever of the large intestine.

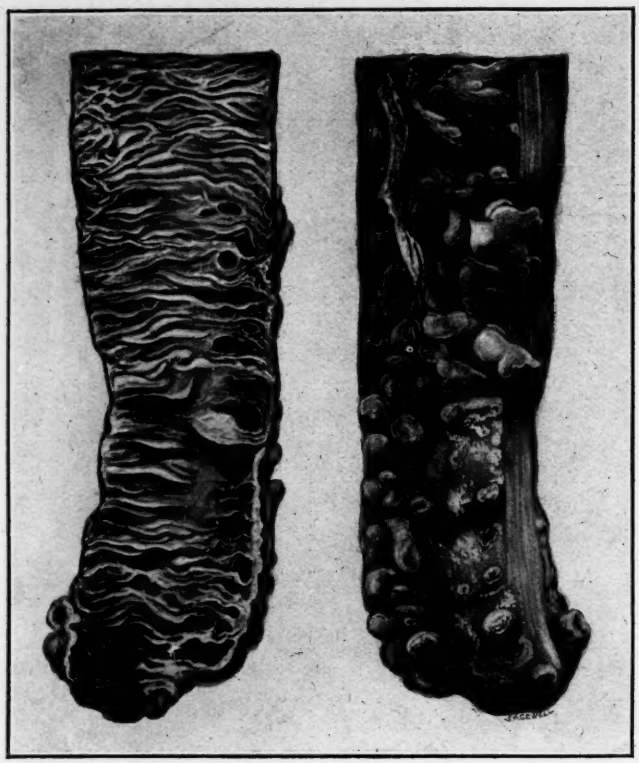


Fig. 48.—Portion of colon with many small sacculi extruded between the fibres of the muscular coat. From a woman, age 69. (*No.* 1628, *St. Thomas's Hospital Museum.*)

A microscopical examination was made of one of the minute sacculi, the mouth of which is not more than 1 mm. in diameter. The sections were made so as to include the mouth, and although the mouth was so minute, on dissecting away the fat from the exterior, the sac was found to project slightly beyond the general level of the muscular wall. The wall of the sac consists of mucosa, furnished with a continuous muscularis mucosæ immediately beneath the crypts, and prolonged from that of the intestinal wall through the neck of the protrusion. The proper muscular coat of the bowel ceases immediately beyond the narrow neck of the sacculus.

## 2. CASES OF STENOSIS.

Mr. Hernaman-Johnson.—*Figs.* 49 and 50 illustrate a case of diverticulitis in a woman, age 60. Examination by an opaque meal and enema established the diagnosis of diverticulitis where cancer of the lower bowel had been suspected previously.

Twenty years ago the patient had had piles removed. Since then she has suffered a good deal from time to time, with discomfort in the lower part of the abdomen, and constipation alternating with diarrhœa. Until six months ago, however, the trouble did not prevent her from leading a very active life. Then she began to suffer from what she described as 'throbbing in the bladder', with increasing frequency of micturition. Also, 'windy spasms' in the lower bowel began to trouble her seriously. Finally she had an attack of partial obstruction, which passed off, after castor oil, with a blood-stained and very foul-smelling stool.

After the obstructive attack, clinical examination suggested the presence of a mass in the sigmoid region; but, owing to the obesity of the patient, the surgeon could not be sure of this. Cancer was suspected.

By means of an *x*-ray examination after an opaque meal the whole alimentary tract showed spasticity to a marked degree; but nothing definite was brought to light until the meal reached the descending colon after forty-eight hours. In the iliac colon and sigmoid were now noticed two or three small round patches of barium food, which were suggestive, but not conclusive proof, of diverticulitis (*Fig.* 49). When the meal was finally evacuated on the fifth day, the evidence was still insufficient for a final decision.

FIG. 49.—Opaque enema *in situ*. Shows diverticula, but no better than with the meal.

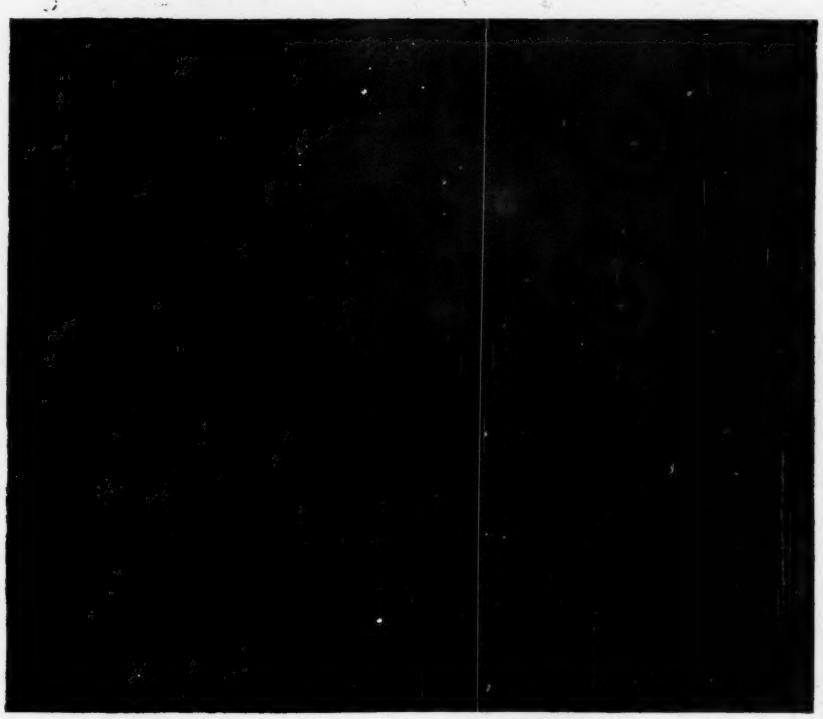


FIG. 50.—The same patient as in *Fig.* 49. After evacuation of enema. Numerous diverticula are shown. (This plate was much under-exposed, but fortunately its diagnostic value is not lessened.)

On the following day, after thorough cleansing by oil enema, a barium injection was introduced with considerable difficulty; this was due to narrowing of the sigmoid. Patches were seen similar to those observed after the meal, but it was not until after the evacuation of the barium enema that the diagnosis became really clear. The residues characteristic of a diverticulitis are well shown in *Fig.* 50, although the plate itself is not a technical success, being under-exposed. The opaque meal was evacuated in stiff masses, with considerable difficulty; on the other hand, the barium enema was a fluid introduced under pressure. These facts no doubt account for the better demonstration of the saccules in the latter case. Both methods are often called for.

At the operation, extensive diverticulitis, with much surrounding inflammation—peridiverticulitis—was found, and the sigmoid was narrowed by adhesive bands. There was no malignancy.

On the other hand, it should be noted that the *x*-ray examination cannot exclude cancer engrafted upon a pre-existing diverticulitis.

Mr. LOCKHART-MUMMERY.—A case of hyperplastic diverticulitis.

The patient was a woman, age 57, with a six months' history of chronic obstruction and frequent small stools 'per rectum'. There was pain in the abdomen, and flatu-

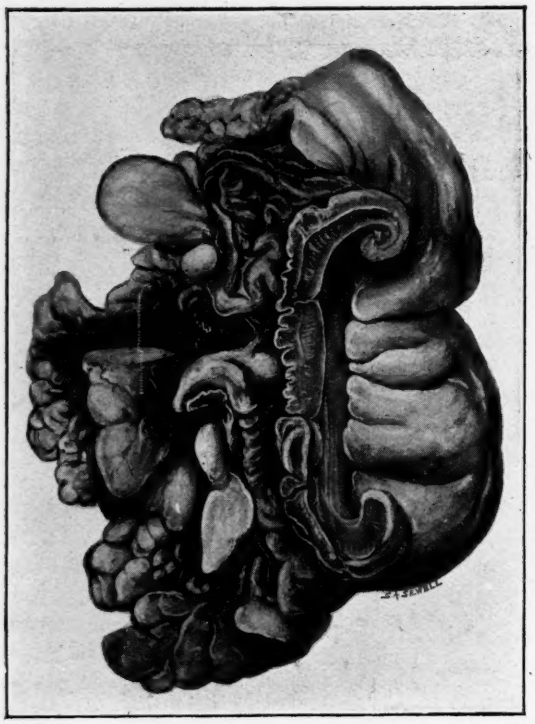


FIG. 51.—Hyperplastic diverticulitis, resulting from inflammation round a large single diverticulum containing a concretion, and producing stenosis and obstruction.

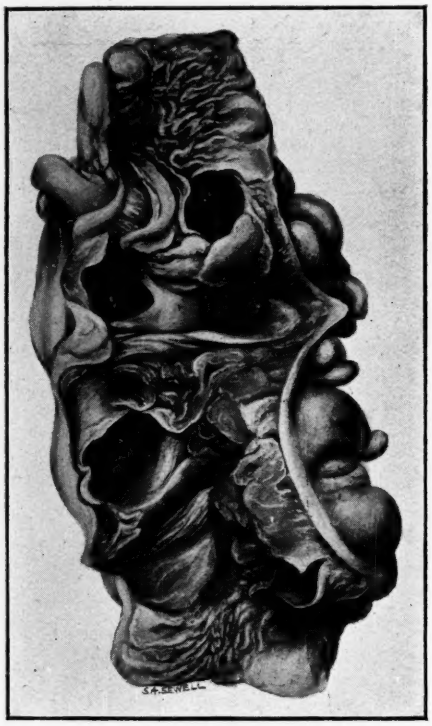


FIG. 52.—Diverticulitis of the pelvic colon. Showing diverticula of unusual size. The necks of the sacs show less constriction than usual.

lence, with a history of chronic alcoholism. At the operation a tight constriction in the centre of the sigmoid flexure was found and resected, with end-to-end anastomosis. The patient died from bronchopneumonia sixteen days later.

The specimen (*Fig.* 51) was thought to be cancer; but on laying it open was seen to consist of a stricture caused by fibrous contraction around a *large single diverticulum* which contained a stercoral stone.

Dr. G. DE BEC TURTLE showed a case in which the patient, a lady, age 69, had been complaining of increasing constipation for the past twelve months. An examination per rectum revealed a mass high up in the pelvis, which was thought to be probably malignant disease of the bowel. As it appeared to be movable, an operation was decided upon, and a preliminary colostomy was performed by Mr. Edmunds. Some three weeks later the tumour and lower bowel were removed through an extensive incision of the posterior vaginal wall.

The patient is making a slow recovery, and it is proposed to close the colostomy wound in the near future.

The specimen (*Fig.* 52) illustrates well the excess of subperitoneal fat. There is little evidence of hyperplasia or stenosis.

Mr. W. MCADAM ECCLES exhibited part of a pelvic colon which has been longitudinally divided to show numerous diverticula, with marked narrowing of the lumen due to fibrous thickening of its wall (*Fig.* 12). The mucous membrane shows chronic thickening and

FIG. 53.—Part of a pelvic colon with many diverticula, divided longitudinally.

pouching, with a number of minute lateral diverticula. At the upper extremity of the specimen is a larger diverticulum with narrow neck and bulbous extremity, which seems to pass into an appendix epiploica. The outer coats of the intestine are of pale-greyish colour, greatly thickened, tough, and fibrous. Strands of fibrous tissue are prominent in the surrounding subperitoneal fat.

Microscopic examination shows no evidence of malignancy, but an extreme degree of chronic inflammatory change, with fibrous thickening of the gut. The diverticula are lined by normal mucous membrane. The specimen was removed on Nov. 11, 1913, from a somewhat stout gentleman, age 74, who for more than a year had been troubled with obstinate constipation and flatulence. The motions never contained blood, but were

always much flattened in shape. A movable elongated tumour, thought to be a carcinoma, was felt in the left iliac fossa. The mass was excised, and end-to-end anastomosis was performed. No enlarged glands were present. Recovery was rapid and complete.

The free surface of the section of the tumour is not bounded by a definite epithelium, possibly owing to the fact that the particular section may be somewhat oblique.

The outermost zone consists of young fibroblasts or fibrous tissue. Deep to this is a layer of longitudinal muscle surrounded by circular muscle fibres. The core of the tumour consists of a loose connective tissue containing numerous blood-vessels and much fibrous tissue.

Sir C. Gordon Watson.—This specimen of hyperplastic diverticulitis exhibits part of a pelvic colon, laid open to show narrowing and inflammation associated with the presence of numerous lateral diverticula (*Fig.* 54). The surrounding peritoneal tissues are loaded

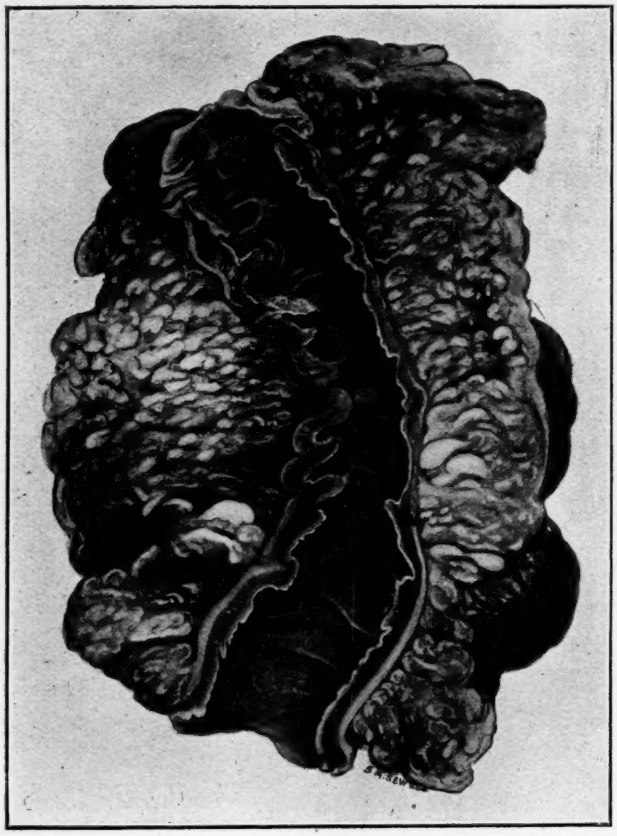


Fig. 54.—Part of pelvic colon, showing hyperplastic diverticulitis.

with fat, and are congested and swollen owing to the nature of the operation described below. The walls of the gut present a pale glistening appearance due to fibrous thickening. The mucous membrane is intricately folded and pouched so as to give rise to pockets and side channels, many of which still contain fæces. Some of these diverticula pass into the appendices epiploicæ, but this is obscured by the swelling of the peritoneal tissues. The lumen of the intestine is considerably narrowed.

The specimen was from a man, age 44, who had had an attack of jaundice twenty years previously. For fifteen years he had suffered from dyspepsia, and had experienced difficulty in complete evacuation of the bowels. Action of the bowels became increasingly

capricious, and three years before the operation blood and mucus were passed with the stools. A tender sausage-shaped swelling could be felt in the left iliac fossa. The abdomen was opened, and the diseased bowel, about six inches in length, was brought to the surface, and there fixed. Eight days later (June, 1914) it was excised and a temporary colostomy established. A year afterwards, in 1915, the colostomy was closed by Mr. Lockhart-Mummery. Two years afterwards (1917) there were recurrent symptoms of

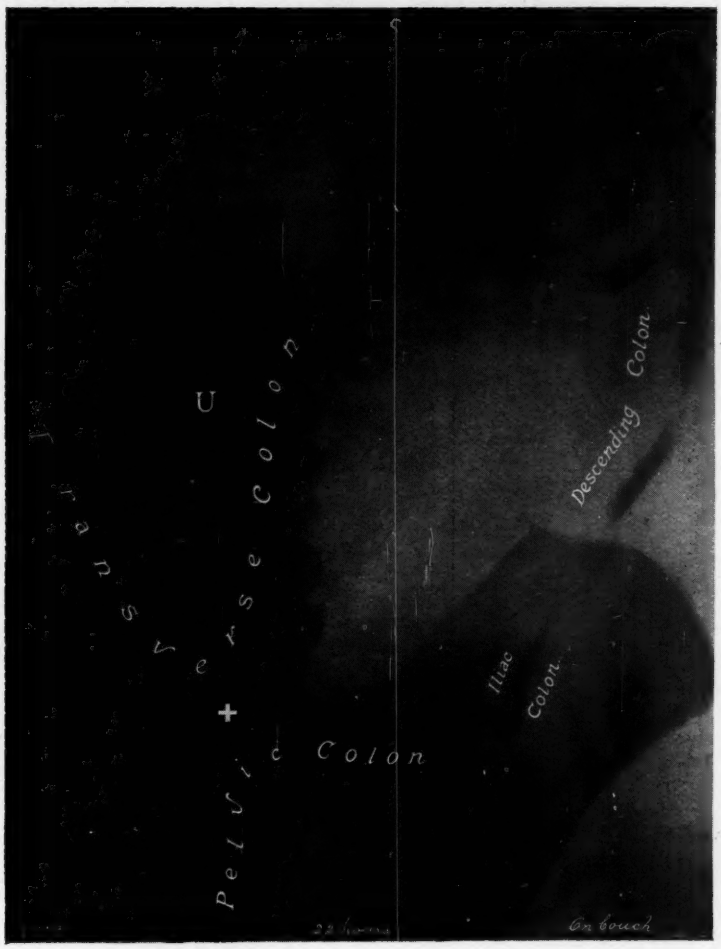



FIG. 55.—To illustrate ileosigmoidostomy after resection of pelvic loop and colostomy and subsequent closure of colostomy.

partial obstruction (diverticulitis above anastomosis). The transverse was now anastomosed to the pelvic colon at the junction with the rectum, and the radiograph (*Fig.* 55), taken a year later, in 1918, shows the anastomosis in function.

### 3. CASES OF PERFORATION.

Mr. CYRIL A. R. NITCH.—Perforating diverticulitis of the pelvic colon.

The patient, a female, age 49, had suffered from constipation for many years. At the beginning of November, 1919, she had an attack of acute colicky pain in the lower part of the abdomen, accompanied by constipation and tenesmus. A fortnight later she had another similar attack, with a slight rise of temperature, and passed some blood and

mucus. When examined bimanually under an anæsthetic, an oval mobile tumour was felt just below the brim of the pelvis on the left side. Sigmoidoscopic examination revealed nothing abnormal in the bowel below the tumour.

At the operation, Nov. 19, a hard, somewhat nodular tumour was found in the middle of the pelvic colon; it ended abruptly, and the bowel immediately above and below looked and felt normal. The adjacent mesentery was thickened, and contained a few enlarged glands. There were no adhesions. The remaining portion of the large bowel, the liver, etc., were examined and found normal.

As the tumour was thought to be a carcinoma, it was resected, and the continuity of the bowel restored by axial anastomosis. The patient made an uneventful recovery. On examining the portion of bowel removed, its lumen was found to be almost occluded by apposition of its walls, due to inflammatory thickening of the submucous coat and hypertrophy of the muscle. An abscess cavity, containing two ounces of odorous pus, was found in the attached mesentery.

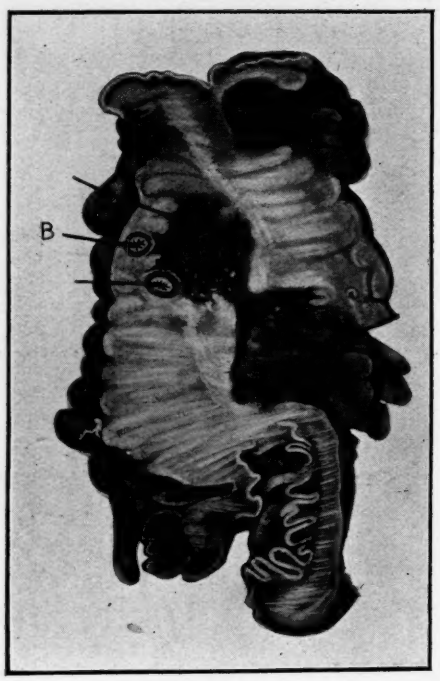



FIG. 56.—Section of pelvic colon showing perforating diverticulitis.

Professor S. G. Shattock has kindly supplied the subjoined description of the mounted specimen (*Fig.* 56):—

Portion of a pelvic colon, which was excised for the results of perforating diverticulitis. As shown at the back of the specimen, it is much contracted, the folds of the mucosa being mostly transverse; from the interior three black bristles have been passed; these emerge from the divided surface of the front of the preparation.

The two lower bristles lie in the lumina of two intestinal diverticula, the cross sections of which are readily discernible on close inspection, whilst the third, and longest, opens into an irregular cavity of necrotic and suppurating pericolic fat, in connection with a diverticulum which has perforated. The suppurating cavity extends across the mid-line to the other side of the bowel. The plane of section, which runs parallel with the gut, shows that the circular muscular coat has undergone a marked hypertrophy; the amount of this is best recognizable at the lower end, where the section has opened the lumen, the much greater thickness of the muscle higher up being due to the coat having been divided on the flat.

Microscopic examination of a section taken at the point B (*Fig.* 56) shows that the fat around the necrotic area is thickly infiltrated with polymorphs, and is hyperæmic, and that the mucosa lining the intestinal diverticula has a perfectly normal structure.

Mr. LIONEL E. C. NORBURY.—Perforating diverticulitis of the iliac colon.

Mrs. R., age 43. History of constipation for fifteen years, with an attack of diarrhœa eleven years ago, lasting for one month. Severe griping pains for the past six months. The right ovary had been removed for tuberculous disease three years previously.

On examination, a swelling was palpable in the left iliac region. On opening the abdomen, an adherent mass was found in connection with the iliac colon, closely simulating a carcinomatous growth. After removing the affected portion of the intestine, some five or six inches in length, the ends were closed and a lateral anastomosis was made. The result was successful.

Upon examination of the specimen (*Fig.* 57) the gut was found much contracted. The walls of the bowel showed hypertrophy and fatty tissue in abundance. On the lower right-hand side of the right-hand half there was an irregular cavity in the fat communicating with the lumen of the gut, due to 'perforating diverticulitis'. In the recent state the cavity contained pus, and pellets of inspissated fæcal matter. Microscopical examination showed all the signs of acute and chronic inflammation. There was no evidence of malignant disease.

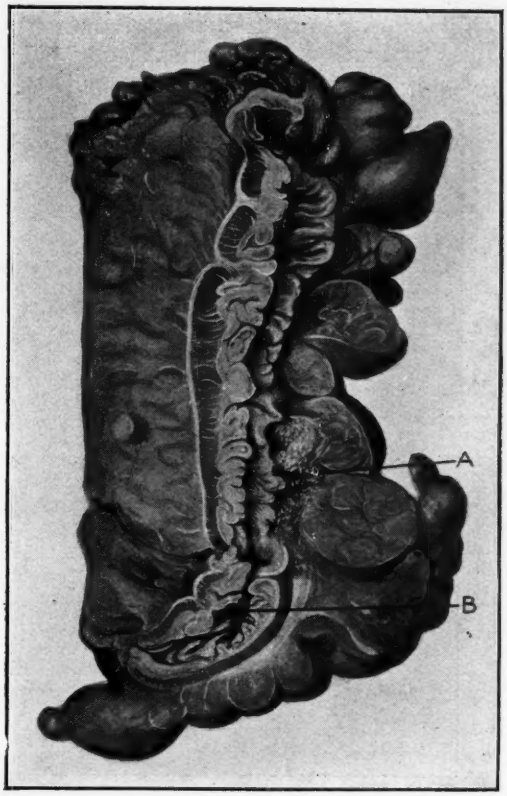
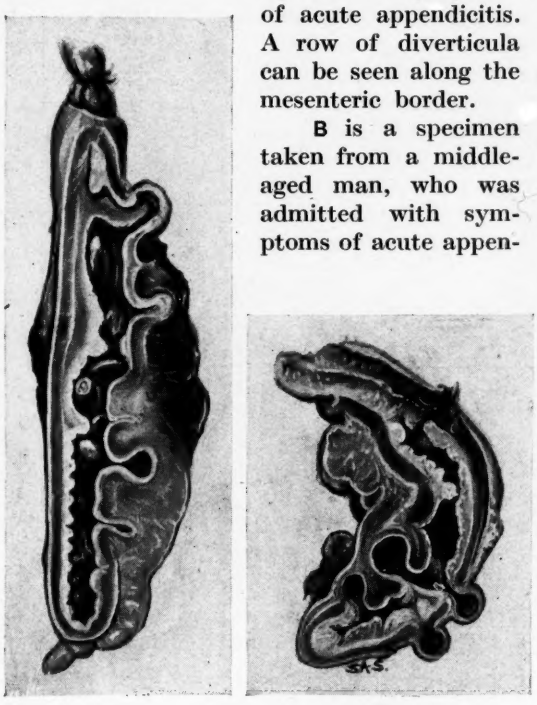



FIG. 57.—Portion of iliac colon, showing perforating diverticulitis. A. Perforated diverticulum: ragged abscess cavity. B. Contracted lumen of bowel.

Mr. EDMUNDS.—Two cases of acute diverticulitis of appendix. The specimen A (*Fig.* 58) is from a young woman, who presented the symptoms of acute appendicitis. A row of diverticula can be seen along the mesenteric border.

B is a specimen taken from a middle-aged man, who was admitted with symptoms of acute appendicitis. At the operation the appendix was found studded with diverticula, one of which had perforated.



A B

FIG. 58.—Acute diverticulitis of the appendix. A. Non-perforating specimen from a young woman. B. Perforating specimen from a middle-aged man.

### 4. CASE OF VESICOCOLIC FISTULA.

The following specimen of a vesicocolic fistula secondary to diverticulitis of the pelvic colon (*Fig.* 59) was not shown at the meeting:—

No. 945, Guy's Hospital Museum. A portion of the sigmoid flexure of a colon with the posterior wall of the bladder, to which it is firmly adherent. There is a fistulous communication, indicated by a rod, between the colon and the bladder. Neither viscus shows any sign of ulceration.

Hans K., age 65, was admitted under Mr. Bryant for the passage of wind and fæces by the urethra. Wind was passed twelve years previously, but no solid fæces until six weeks before admission. He had been in the tropics, but had never had symptoms of dysentery. Colotomy was performed, and the patient died three days later. At the autopsy there were signs of former ulceration in the rectum six inches from the anus, but none in the bowel higher up.

Description in catalogue: "Much thickened sigmoid, which is contracted to some extent; unduly rugose but practically normal mucosa. There is a very chronic perisigmoiditis, and a large mass of inflammatory tissue between it and the bladder; a small fistulous communication exists between them". This is an instructive and typical specimen; the thickened, stenosed, and rugose bowel, with two inches of inflammatory thick-

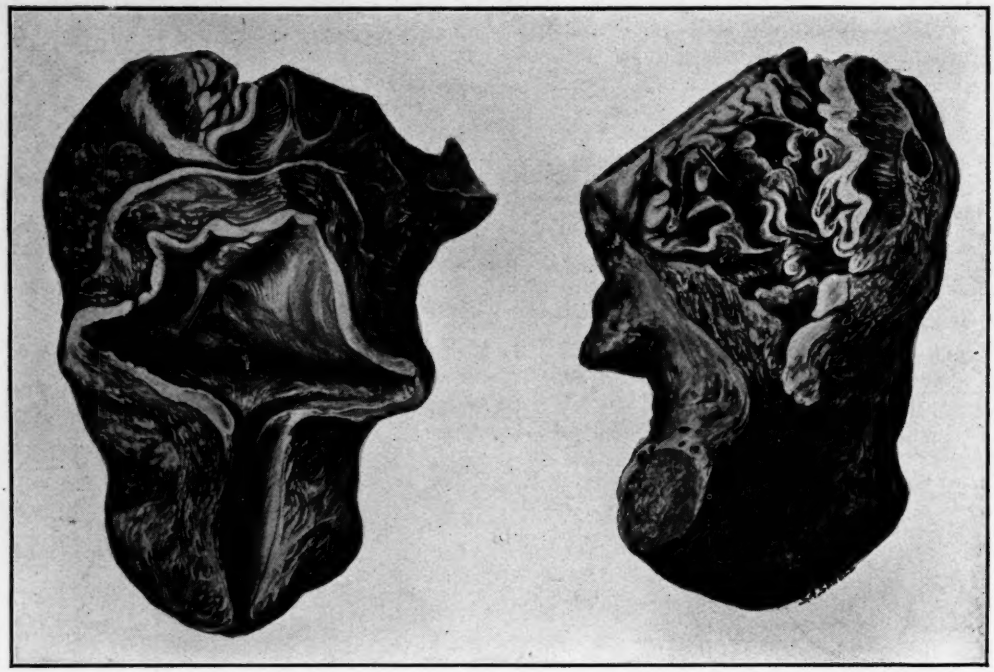


FIG. 59.—A case of vesicocolic fistula. (*No.* 945, *Guy's Hospital Museum.*)

ening between the bladder and the bowel. Into this can be seen extending in two or three places diverticular passages, cut more or less obliquely across, and lined with smooth mucous membrane. Beneath the rugæ, and not obvious until searched for with a probe, are the small orifices of many diverticula half an inch or more in depth. The fistula is a tortuous passage communicating with a small nut-sized abscess cavity.

# SPECIMENS SHOWING THE EFFECTS OF GUNSHOT INJURY ON THE HEART AND BLOOD-VESSELS:

## NOW ON EXHIBITION IN THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS OF ENGLAND.

By Sir GEORGE HENRY MAKINS.

In a previous issue of this journal,[1] some illustrations of the lesions of the blood-vessels resulting from gunshot injury will be found, and a further series appears in the writer's monograph on *Gunshot Injuries to the Blood-vessels*.[2]

The present communication contains a third series intended to supplement those which have already appeared, and to fill up some gaps in the pictorial delineation of the lesions concerned. All the specimens, depicted with admirable skill and exactitude by Mr. A. K. Maxwell, may be seen in the War Collection in the Museum of the Royal College of Surgeons. The specimens themselves exhibit the unrivalled skill of Mr. C. F. Beadles as a dissector.

### INJURIES TO THE PERICARDIUM AND HEART.

Perforating injuries to the pericardium are not of rare occurrence; a large number are no doubt included amongst the class of case in which the position of the apertures of entry or exit renders it a source of surprise that the heart itself could have escaped injury. Many of these are of minor importance, they are accompanied by slight or by no symptoms, and, unless the heart itself has been scored, hæmorrhage may be minimal or absent. Even the sign of pericardial friction is not always detected in the minor injuries. The fact that missiles may enter the pericardial sac, become fixed, and cause but little trouble or distress, is founded on ancient observation, and the experience has been repeated in the late war. In other instances, however, a foreign body, although fixed in the pericardial sac, has been found to be a source of permanent irritation, giving rise to pain and disorder of the heart's action on exertion.

In the great war the foreign body, being so frequently a fragment of shell or bomb, has acquired a more weighty significance, since it has been a source of infection, and examination of the specimens in the collection shows how commonly pericarditis ended in death, where a wound by a bullet might have been followed by minor consequences. Naturally the heart escapes only when the wounds of the pericardium occupy the marginal area of the sac; when they occupy the more central portion the heart is commonly implicated.

*Figs.* 60 and 61 (W.O. 1486) illustrate an extreme instance of the escape of the heart from gross injury, even when the pericardium has suffered an extensive laceration in its central part. Such a lesion could only be produced by a fragment of shell travelling at a comparatively low degree of velocity; yet this specimen shows that very considerable force was exerted upon the sternum.

The patient, a gunner, age 25, was admitted into No. 7 Canadian General Hospital under Major Platt. The man was very ill. Two wounds were present: one of the left arm, the second an opening into the left side of the thorax an inch outside the heart. Respirations were rapid, the pulse weak and irregular. There was pus in the left pleura, and the cardiac dullness was increased in extent. Sixteen days later an attack of hæmorrhage occurred, and the man died the same day. The condition throughout

FIG. 60.—Comminuted fracture of sternum caused by a missile striking its posterior aspect.

FIG. 61.—Extensive laceration of the pericardium accompanying the fracture seen in *Fig.* 60.

had been so serious as to negative the question of submitting the patient to the strain incumbent on an *x*-ray examination.

At the autopsy the wound in the arm was found to have perforated the biceps without causing injury to the humerus. The aperture of entry in the chest wall was situated above the left nipple, and thence the missile had passed between the ribs and caused a comminuted fracture of the sternum at the level of the junction of the third costal cartilages. *Fig.* 60 shows the missile in position, and one large fragment of the comminuted fracture completely stripped of its coverings. The fracture extends over the entire width of the sternum. The fragment of the shell lay in relation to the right auricle of the heart, and a trifling injury to the wall of the right ventricle was evident while the specimen was in the fresh state. *Fig.* 61 shows the extent of the laceration of the pericardium. About three ounces of blood were present in the cavity of the sac at the time of the post-mortem examination. The lungs were engorged with blood, and the abdominal viscera soft and pale.

Some of the specimens show smaller lacerations of the pericardium produced by missiles which wounded it in passing without entering the sac.

W.O. 1678 illustrates the amount of injury which may be produced by a very small fragment. The mediastinal tissue on the outer surface is infiltrated by blood. When viewed from the inner aspect, a puncture sufficiently large to allow the passage of a fragment an eighth of an inch in diameter is surrounded by an irregularly circular area of subserous ecchymosis some four inches across. The anterior surface of the right ventricle is bruised, with subepicardial ecchymosis; there is a dent upon it, and a second dent on the posterior surface of the heart. The small missile lay in the posterior part of the pericardial sac. There was a small quantity of altered blood, and one 'shaggy' adhesion on the front of the heart. The patient from whom the specimen was removed lived twenty-two days, and died from pyæmia. There is no reason to believe he would not have recovered from the injury to the pericardium and heart.

## WOUNDS OF THE HEART.

*Fig.* 62 (W.O. 657) illustrates a wound of the left ventricle of the heart. The specimen was obtained from a man who died shortly after admission to No. 13 General Hospital by Captain H. H. Henry.

A grazing tangential wound caused by a small fragment of shell was present in the left mid-axillary line. Widespread ecchymosis extended to the mid-line anteriorly, and downward to the anterior abdominal wall. The 4th and 5th ribs were fractured in the left mid-axillary line, with some comminution. There was a laceration of the left lung, with a few patches of fibrinous clot about the base of the left pleura, and one or two ounces of free fluid blood in the pleural cavity. No wound was discoverable in the pericardium, but an infected linear wound (see inset) about three-quarters of an inch long on the anterior wall of the left ventricle. The area around the wound showed septic ecchymoses, and there was slight pericarditis. Within the cavity of the ventricle a firm fibrinous clot occupies the site of the wound, and is firmly attached. In the specimen it has been sectioned. No vegetations are to be seen on the mitral valve.

The right lung, the liver, and the spleen were normal. Both kidneys showed septic infarcts, originating from the surface of the clot in the ventricle.

This specimen offers some difficult problems. The condition is readily explicable if we assume the passage of a small fragment of shell from the left side of the chest through the lung to the cavity of the left ventricle, whence it was carried into the general circulation. In fact, no track was found in the thoracic parietes, nor any opening in the pericardium. Further, no evidence of a foreign-body embolism is furnished. On the other hand, the wound in the heart was an infected one, which would seem to negative the idea that it could be the result of a rupture. I think the simple explanation must be accepted, and we must assume that the original track was rapidly obliterated.*

* In connection with this case, one reported by Messrs. G. R. Turner and Leslie Pearce Gould is of interest (*Lancet*, 1917, ii, 567).

FIG. 62.—Wound of the left ventricle. Internal thrombus displayed by section. Inset: Wound as seen on surface of heart.

The most remarkable remaining feature is that no hæmorrhage had occurred into the pericardium, and that the wound in the wall of the heart became blocked by clot, while an internal thrombus formed, just as is the case in wounds of the large blood-vessels.

*Fig.* 63 (W.O. 571) furnishes another example of a perforating wound of the heart caused by a small fragment of shell. The missile entered the thorax from the abdomen, perforated the wall of the left ventricle just above the apex, grooved deeply the posterior wall of the ventricle, wounding the root of one of the papillary muscles, and after traversing the interventricular septum is seen to be lodged amongst the columnæ carneæ of the right ventricle.

It is noteworthy that in this instance but little trace of fibrinous clot has formed on the exposed surface of the cardiac muscle.

*Fig.* 64 (W.O. 2107) affords a remarkable example of an infected wound of the heart. The patient was wounded at 10 p.m., and admitted into No. 17 Casualty Clearing Station on the following day, under the care of Captain R. Bertram Blair. Two small wounds were found in the left mid-axillary line over the 5th and 6th intercostal spaces respectively. There was also an aperture of entry in the left lumbar region, and two entry wounds were present in the upper third of the left thigh.

Physical examination revealed dullness extending to the left scapula, and pericardial friction. The right chest was normal. On the third day an examination with the fluorescent screen showed a foreign body with a 'flail-like' movement, and also moving up and down with respiration, which was located to the chamber of the left ventricle. Half an hour after the man's return from the *x*-ray room the left lower extremity was noted to be blue and cold to above the level of the knee. The limb was raised upon a pillow, and after an interval of an hour regained its normal aspect.

On the fourth day the *x*-ray examination was repeated, and the foreign body, which had been located to the left ventricle, was now seen half an inch below and to the left of the umbilicus, i.e., at the point of bifurcation of the abdominal aorta. Nitrous oxide anæsthesia was induced, and fragments of shell were removed from the lumbar region and left thigh. The wounds were dirty, and suggested early 'gas gangrene'. The left pleura was aspirated and ten ounces of blood were drawn off. Cultures made from the blood proved negative. On the fifth day the man died from toxæmia due to anaerobic infection, and fifteen hours after death an autopsy was performed.

At this time there was emphysema of the face and neck. A small quantity of blood was found in the left pleura and in the pericardium. There was a hole at the lower and back part of the pericardium, and a fibrinous exudate clothed its anterior and left lateral wall. The small aperture of entry in the posterior wall of the left ventricle was found, and a ragged laceration on the surface of the interventricular septum. A jagged tear of the apex of one of the papillary muscles is also seen. The myocardium was very pale and full of gas bubbles. The foreign body was discovered at the bifurcation of the left common iliac artery, surrounded by dark-red blood-clot. The intima of neither the iliac artery nor the aorta had suffered any damage. A small hæmorrhagic infarct with indriven bone was found in the left lung, also apertures of entry and exit in the anterior portion of the lower lobe.

The illustration exhibits all these points. The infiltration of the myocardium with gas is no doubt a post-mortem development. The most striking features are the absence of any large quantity of blood in the pericardium although the patient lived five days, and the passage into the left iliac vessels of the fragment of shell which caused the wound. It may be remarked that the right iliac vessels are the more common recipient of travelling foreign bodies.

The next three specimens are of less clinical interest, since they represent fatal injuries; on the other hand, they illustrate the amount of destruction which the missiles of war are capable of producing.

*Fig.* 65 (W.O. 453) is of the greater interest. The patient, together with a second flying officer, were both struck by armour-piercing bullets. Both were dead when the aeroplane reached the ground, but this heart was that of the pilot, and the fact that the

FIG. 63.—Perforating wound of heart, injury to base of papillary muscle. Missile (M) lodged in cavity of right ventricle.

FIG. 64.—Perforating wound of left ventricle. Non-perforating wound of interventricular septum
Post-mortem extension of anaerobic infection in myocardium

FIG. 65.—Serious limited destruction of myocardium produced by a deformed armour-piercing bullet.

machine was safely brought to a landing-place leads to the inference that in his case death was not immediate, in spite of the extent of the cardiac lesion.

As will be seen, the destruction of the myocardium is very extensive, and there is considerable subpericardial ecchymosis. The cavity of the ventricles is not impinged upon. Broken fragments of a bullet found in the machine suggest that the fatal missile may have struck some part of the plane and become deformed.

*Fig.* 66 (W.O. 2614) depicts a specimen secured by Captain T. H. G. Shore at the camp at Etaples, and is an example of a self-inflicted rifle wound. The muzzle of the rifle had been placed against the man's chest. The aperture of entry of the bullet, surrounded by an area of burned skin, was situated three inches above the left costal margin, one and a half inches within the left nipple line.

The bullet had traversed the heart, inflicting the injury depicted, and causing a large rent in the diaphragm through which the stomach was found prolapsed. The aorta was torn across immediately below the diaphragm, the left lobe of the liver was torn, and the bullet had injured the greater curvature of the stomach close to the œsophageal opening. The remaining abdominal viscera were uninjured. A little blood-clot was present in the left pleura, but the lung had escaped any damage. There was some hypertrophy of the left ventricle of the heart, and chronic nephritis of the type of the small white kidney. The aperture of exit, smaller than the entry wound and with everted edges, was situated in the right loin, one and a half inches from the mid-line.

At the post-mortem the remaining portion of the apex of the heart was found displaced upwards by the herniated stomach. It is impossible to say whether the heart was struck in a state of systole or diastole, but the specimen is the only one which raises the question of hydraulic explosive effect.

Inspection of the specimen appears to show some signs of contusion of the broken margin of the right ventricle ; otherwise the suggestion is of a more or less clean tear with radiating extensions, the widest of which is prolonged to the auriculoventricular groove. The comparison with the burst paper-bag inevitably arises, although the condition might be equally well produced by a combination of crushing and tearing, which would be in consonance with the expression 'blown away', employed in the original description of the specimen, and which would be the obvious explanation if the heart was struck during the period of contraction.

*Fig.* 67 (W.O. 530) illustrates the extreme severity, and yet the localization, of the injury which may be produced by a large fragment of shell. The wall of all four chambers of the heart is seen to be reduced to tatters ; yet the organ retains its general form and continuity.

The specimen was obtained from the body of a gunner who, while sitting on the limber only a few yards from the entrance to a casualty clearing station, was struck by a fragment of a shell which burst a few yards away from him. The missile traversed the sternum, damaged the heart as shown in the illustration, comminuted the vertebral column, and escaped from the back. The man fell in a pool of blood, and the heart was removed shortly afterwards by Lieut.-Colonel E. M. Cowell.

The above series of specimens is all of injuries to the ventricles, and it is a significant fact that the series of wounds of the auricle is much less numerous in the collection. It must, I think, be assumed that hæmorrhage is more likely to be abundant when the auricle is wounded. There is little chance that the gap in the wall can contract, and no possibility that the missile can plug the opening as is sometimes the case with the ventricle.

Some specimens in the collection, however, prove that death is not always an immediate result of wound of the auricle. Thus W.O. 2265 is a specimen removed from a man who was struck by a small fragment of shell over the 9th right rib. The patient was brought a distance of fifteen miles to a casualty clearing station, where the wound was explored and found to involve the diaphragm. The wound was excised, and the gap in the diaphragm closed by suture. Later on the same day death occurred.

At the autopsy the missile was found to have traversed the right auricle and lodged

FIG. 66.—Self-inflicted rifle-bullet injury to the heart. The appearances suggest hydraulic explosive effect.

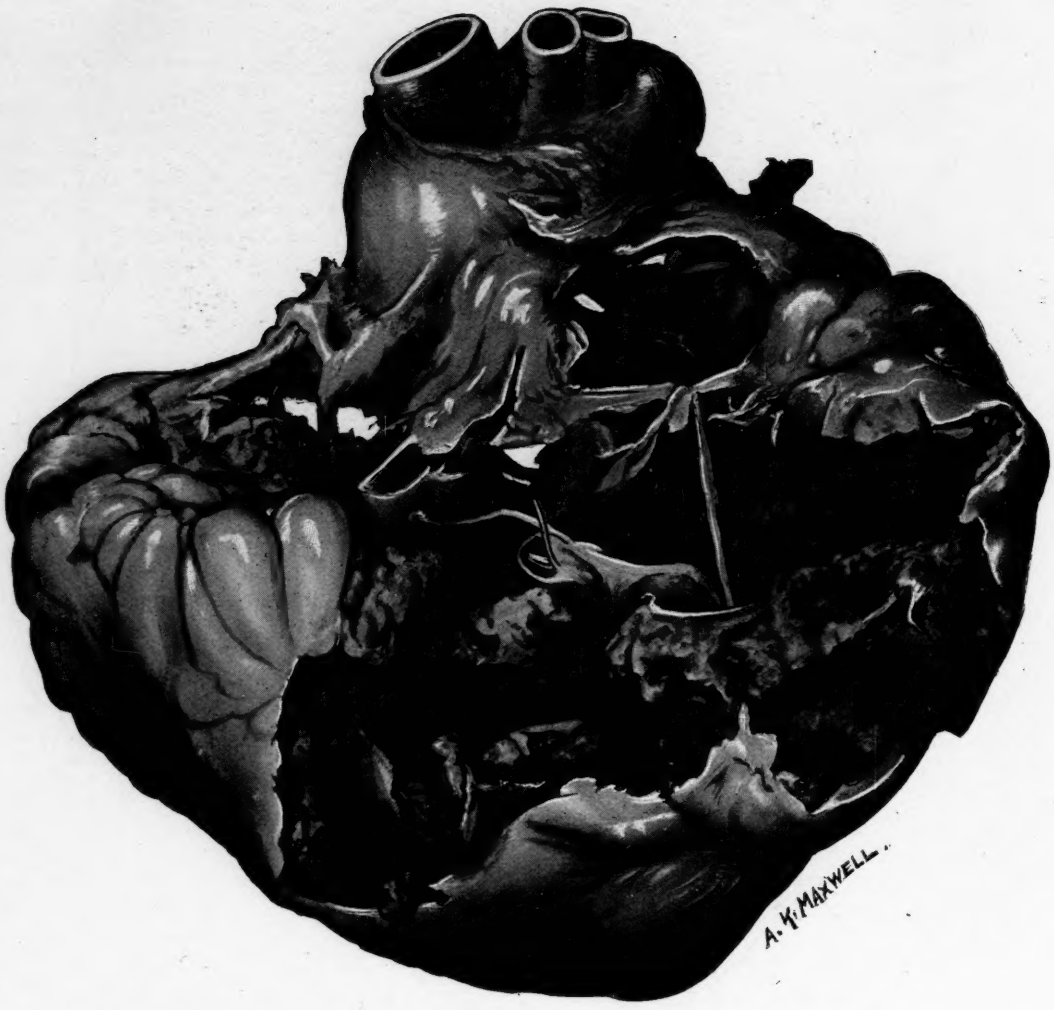



FIG. 67.—Extreme laceration of the heart caused by a fragment of high-explosive shell.

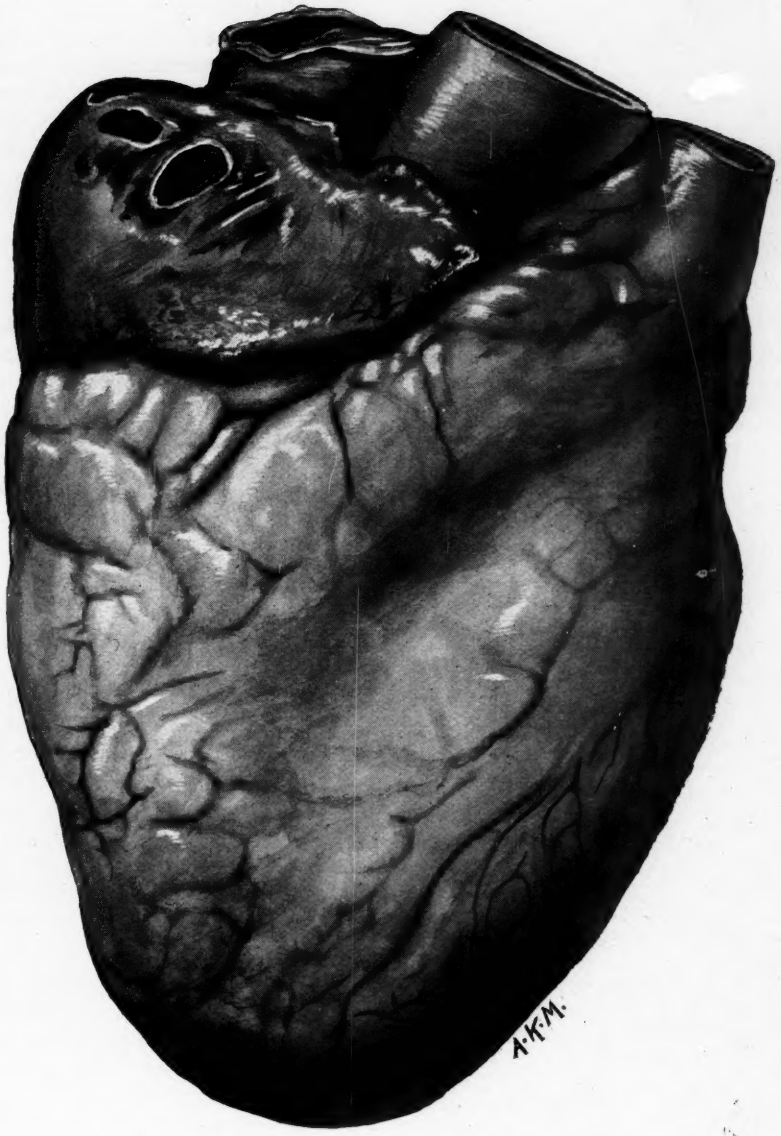



FIG. 68.—Perforating wounds of the right auricle.

in the pericardial sac in the pouch beneath the pulmonary artery. No record was kept of the amount of blood found in the pericardial sac after death.

FIG. 69.—Direct extension of infection from a wound in the internal jugular vein to the heart.

W.O. 2108. This specimen was removed from the body of a man who died on the third day. When admitted to the casualty clearing station he was in a state of collapse. The fragment of shell entered the fourth right intercostal space one inch from the margin of the sternum. It perforated the anterior border of the lower lobe of the right lung, entered the right auricular appendix, and passing through the auriculoventricular opening was arrested in the apex of the right ventricle.

Death resulted from purulent pericarditis, and at the autopsy an antemortem clot occupied the right auricle, extending through the tricuspid opening into the right ventricle, almost blocking the passage.

In a third case, W.O. 1921, a fragment of shell entered at the pectoral fold, fractured the 3rd rib, passed through the upper lobe of the left lung, perforated the pericardium, and gave rise to a rounded laceration of the wall of the left auricle at the base of the auricular appendix. After death the missile was found in the left pleural sac, which was full of blood. The missile therefore appears in passing to have perforated both the pericardium and the auricle without actually entering the sac. No record was furnished as to the date of death, nor as to the amount of blood found in the pericardium.

A fourth specimen (*Fig.* 68) (W.O. 1405) was used by Captain Cowell to illustrate the occurrence of death from shock. The patient, a German private, was wounded by a bullet which produced three rounded holes in the right auricle, each large enough to admit a pencil. Two ounces of fluid blood were found in the pericardium ; the right ventricle was contracted and empty. The face of the patient was cyanosed.

A general survey of these specimens throws light on some of the problems of injuries to the heart which have often been discussed.

In the first place, abundant proof is furnished that the heart may sustain very severe injury without causing the immediate death of the patient. In fact, in only three of the cases here quoted did immediate

death result: in two from actual destruction of the organ, and in the third from shock. In the latter, however, the amount of injury to the auricle was so great that further action of the heart would have been impossible. It must be remembered, too, that these specimens were practically all obtained from hospitals, and probably represent the proportionately few patients who survived the injury.

The specimens delineated in *Figs.* 62, 63, and 64 also show that considerable perforating wounds of the ventricle may occur without serious hæmorrhage into the pericardial sac resulting; in the case shown in *Fig.* 62 absolutely none occurred. This is generally to be explained by contraction of the opening by the muscle of the heart and the deposition of clot in the track; in some cases possibly by the impaction of the missile in the opening (W.O. 2522).

In relation to these remarks it will be observed that all but two of the injuries here figured were produced by fragments of shell, and that the latter were in most instances retained, an evidence of a low degree of velocity and striking force on the part of the missile. We know also that bullets travelling with a low degree of velocity may be retained in the wall of the heart without causing death. The two exceptions are those of the wound of the auricle referred to, and the self-inflicted rifle wound, in which the destruction produced was extensive.

While, therefore, there is little reason to doubt the common occurrence of death from shock when the heart is hit, the general weight of evidence is in favour of a more common escape from immediate death than has been commonly held to be the case. It seems probable that in many of the instances in which the position of the apertures of entry or exit of bullets suggests that the heart has been wounded, and in which, from the absence of symptoms, we have concluded that the organ has escaped injury, we have not had tenable ground for the assumption. The specimens of injury to the ventricle at any rate strongly support this opinion. They further show that, in cases of injury by fragments of shell, pericarditis of an infective character is the most frequent cause of death.

*Fig.* 69 (W.O. 2209) is appended to this series to illustrate the direct extension of an infection from a wound in the neck to the endocardium.

The patient was wounded by a shrapnel ball which entered just above and outside the left angle of the mouth, fractured two bicuspid teeth, and passed by the left side of the tongue into the right anterior triangle of the neck, where it was retained. A few days later the shrapnel ball was removed from a small septic cavity in direct relation to the right internal jugular vein. A little venous bleeding followed, but was readily controlled. The man died at the end of the month as a result of general infection. The wound on the right side of the neck was in a septic condition, and the cavity was connected with the internal jugular vein. The vein was thrombosed from this spot down to the valve at its root. Beyond this point the lumen was occupied by post-mortem clot, with a small strand of adherent ante-mortem clot in its midst.

It will be seen that the right auricle is distended with recent dark blood-clot, while around the tricuspid opening, and upon the valves, are massive vegetations. The remains of the septic cavity in the neck, and its connection with the jugular vein, are indicated in the drawing by a glass rod. In the lungs were a number of septic infarcts. The liver was pale and fatty, the spleen was soft, and the kidneys were pale; these viscera exhibiting the common characters of those met with in cases of general infection.

## INJURIES TO THE BLOOD-VESSELS.

A series of illustrations depicting both the gross appearances and the histological details of the types of contusion produced by gunshot injury will be found between pages 9 and 15 of the monograph already referred to.[2]

*Fig.* 70 (W.O. 1945) is inserted to complete the series by a specimen showing one of the slightest types, that in which a contusion is accompanied by the formation of small fissures in the intima, such breaches of surface becoming clothed by coagulum and thus furnishing a potential source of peripheral emboli. The specimen was obtained from the

body of a man who died on the fifth day as a result of a wound caused by a fragment of an aeroplane bomb.

The missile entered the body below the middle of the 12th rib upon the left side. Thence it entered the abdomen, cut a deep groove in the posterior surface of the left kidney; then crossed and bruised the aorta just above the origin of the inferior mesenteric artery, passed through the lower edge of the head of the pancreas, and entered the stomach in the neighbourhood of the pylorus. The fragment of bomb was vomited by the man three hours after reception of the injury. At the autopsy an acute ulcer was found on the anterior wall of the stomach just above the greater curvature, three inches from the pylorus. The ulcer was three-quarters of an inch in diameter, it had soft clean-cut edges, and the floor was formed by the exposed muscular coat. The drawing shows well the result of the contusion of the aorta.

FIG. 70.—Contusion of abdominal aorta Fissuring of intima, with minimal deposition of clot.

The next series consists of specimens of foreign bodies either impacted, or forming artificial emboli and thus obstructing the blood-stream.

Obstruction of the blood-stream by pressure of impacted missiles from without the vessels, with or without gross damage to the wall, are familiar enough to the surgeon. Such missiles occasionally become permanently incorporated in the vessels and entirely occlude them. An example from the practice of Sir Charters Symonds is figured on page 16 of my monograph (*Fig.* 7).

FIG. 71.—Transfixion of femoral artery by a flattened machine-gun bullet.

*Fig.* 71 (W.O. 1922) shows a flattened machine-gun bullet which has transfixed the femoral artery in the lower portion of Hunter's canal. The patient had received severe flesh wounds of the left forearm and right thigh. A foreign body could be felt at the lower end of one of the tracks in the thigh. Captain Hood cut down on this, and found the femoral artery as depicted. No local hæmorrhage had occurred, and the femoral vein had escaped damage. No tibial pulse could be detected in either limb.

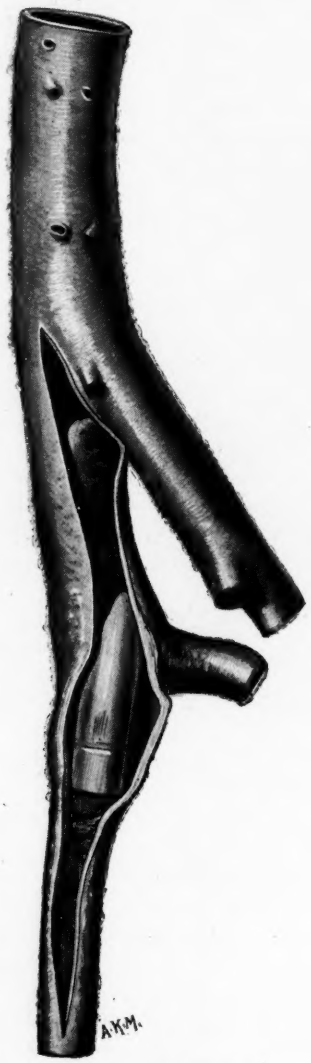


FIG. 72.—German bullet in external iliac artery, base downwards.

The portion of artery was excised, and the vessel ligatured above and below.

*Fig.* 72 (W.O. 2413) depicts a regulation German bullet lying base downwards in the right external iliac artery, the body of the missile lying across the origin of the internal iliac, and its point still in the common trunk.

The bullet entered the thorax, traversed the lung, and perforated the thoracic aorta. (An illustration of the slit wound of the aorta is seen in *Fig.* 33, p. 114, of my monograph). The injury to the lung resulted in the formation of a large hæmothorax, from which four pints of blood were evacuated at the end of twenty-four hours. The wound of the aorta was surrounded by some interstitial mediastinal hæmorrhage of very moderate degree. The patient died on the fifth day as a result of an acute streptococcus infection of the pleura.

It will be noted that a thrombus an inch and a quarter in length at either end of the bullet completely obstructs the common and external iliac arteries. The embolus does not appear to have given rise to any threatening symptoms. The specimen was secured by Captain Adrian Stokes. There seems little doubt that the wound of the aorta was a negligible factor in this case.

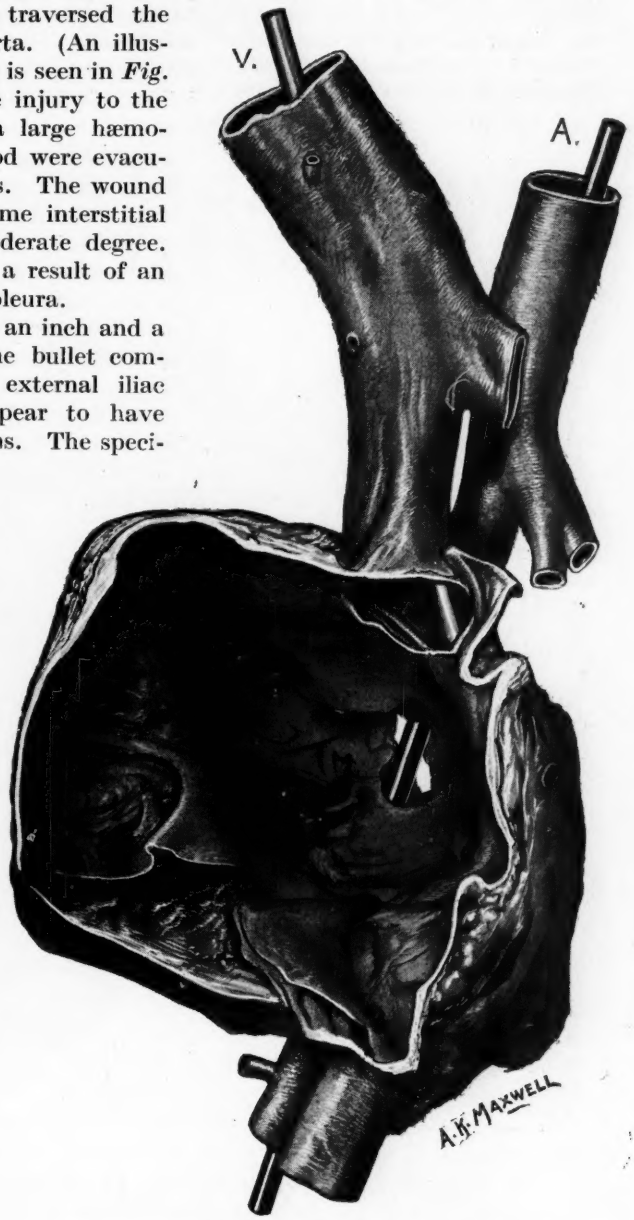



FIG. 73.—Arteriovenous hæmatoma in connection with the external iliac vessels. Separate openings of artery and vein.

*Figs.* 73 and 74 (W.O. 3071) are of one of the most remarkable instances of a travelling bullet ever put upon record. A full history of the case by Captain H. J. B. Fry will be found in the *Lancet*.[3]

The bullet entered half an inch below the left anterior superior spine by a small oval wound. It wounded the back of the left external iliac artery and then entered the satellite vein. Thence it was carried by the blood-stream to the right auricle, traversed the ventricle, the pulmonary valve, and pulmonary artery, to enter its left branch, and eventually become impacted in one of the branches supplying the lower lobe of the left lung, in which it gave rise to two infarcts.

The patient, when admitted, stated that he had felt a sharp stinging pain in the left foot when hit, and assumed that the wound was in that position. The left limb was cold, œdematous, and painful; the foot was puffy and discoloured, and there was neither a palpable peripheral pulse nor any capillary reaction. A humming murmur was heard, and a palpable thrill was detected below and to the left of the umbilicus. No evidence of a retained foreign body was obtained by an *x*-ray examination of the area of the body between the umbilicus and the knees.

Captain Fry gives the following clinical history :—

For a week the patient's general condition remained good. There was some collapse of the bases of both lungs. A 'hæmic' systolic murmur was present at the apex of the heart, and it was especially loud in the pulmonary area. The pulse was rapid (136), full, and soft ; blood-pressure 95 to 100 mm. Hg ; respirations rapid (36) and shallow. There was a slight icteric tinge of the skin of the face and conjunctivæ, and considerable œdema of the back. Urine showed a faint trace of albumin, a few urinary epithelial cells, and one or two degenerated granular casts. The day after its receipt the wound was almost healed and the ecchymosis of the loin had

FIG. 74.—Bullet which travelled from the left external iliac vein, impacted in one of the branches of the left pulmonary artery.

disappeared, but gangrene of the left leg was complete, and the leg was therefore amputated below the knee by Captain Le Mesurier.

The patient's condition improved for a short time, but in a few days the amputation stump became gangrenous. A booming cavernous note was detected in the aneurysmal murmur, and respiration, which had always been shallow and rapid, became gasping and very rapid, with a greatly increased pulse-rate. Finally, the patient became delirious, the pulse uncountable, and respiration-rate rose to 60 to 70. The temperature steadily mounted, and the patient gradually sank, and died in coma, one month after receipt of the wound.

At the autopsy there was widespread retroperitoneal ecchymosis, and a large aneurysmal sac. The aorta appeared contracted and rather shrunken; the left common iliac artery was small. Both vessels contained a little recent clot. The inferior vena cava was large and dilated, as were also the renal and common iliac veins, especially the left. The left femoral artery was small, collapsed, and empty, but the femoral and internal saphenous veins were large and thrombosed. On removal, the left external iliac artery was found to communicate with the aneurysmal sac by an opening on its posterior surface immediately below the origin of the internal iliac (*Fig.* 73). The artery was patent both above and below. The external iliac vein opened into the front of the sac by a separate opening at a somewhat higher level. The vein was thrombosed below this opening, so that arterial blood entering the sac at once passed backwards into the venous circulation.

The bullet which had caused the injury was discovered in the branch of the left pulmonary artery passing to the lower lobe. The lumen of this vessel and a smaller lateral branch were completely blocked, and two infarcts in the lung corresponded with the peripheral distribution of the occluded branches.

Captain Fry states that "from measurements *in situ* and standard measurements, the distance travelled by the bullet in the blood-stream was not less than two feet. Since the blood-pressure in the inferior vena cava in the normal condition is about + 3 mm. Hg, and diminishes in the veins of the chest and the right auricle to − 8 mm. Hg, while the velocity of the circulation is not above 25 cm. per second, it is probable that the blood-pressure in the abdominal veins must have been greatly increased through the formation of the arteriovenous aneurysm, to have enabled the venous flow to sweep such a comparatively heavy weight as 10 grm. along the veins. The condition, indeed, was one in which the patient was bleeding into his venous circulation."

The same departure from the normal condition has been seen to be the explanation of gangrene of the foot resulting from simple proximal ligature of the femoral artery in femoral and popliteal arteriovenous aneurysms.[4]

Specimen W.O. 1791 shows a small piece of shell, lodged in the apex of the cavity of the right ventricle of the heart, which entered the circulation by perforating the inferior vena cava.

FIG. 75.—Broken shrapnel ball occluding left common iliac artery.

*Fig.* 75 (W.O. 2208) represents the common iliac artery blocked by half a shrapnel ball. The patient, age 35, was struck in the posterior right axillary line, the ball entering the chest. There was much ecchymosis over the lower ribs behind, and subcutaneous emphysema around the wound. When admitted to hospital the man's colour was good; there was slight dyspnœa. The heart was normal. On the eighteenth day the condition was improved, and an *x*-ray examination of the chest showed no sign of a foreign body. The following day a sudden attack of pain was followed by death. No mention is made of any sign of obstruction of the iliac artery.

At the autopsy, performed by Captain Shore, two or three ounces of fluid, with large blood-clots of evident recent origin, were found in the right pleural cavity, and there was a bullet track in the right lower lobe of the lung, along which spicules of the 7th rib were distributed. The right upper lobe showed bronchopneumonia; the lower lobe was

collapsed. A thin-walled false aneurysmal sac in connection with a large wound of the aorta, two inches below the arch, projected into the left pleural sac. No definite rupture of the sac could be discovered.

The shrapnel ball is seen in position, with a proximal clot extending backward to the bifurcation of the abdominal aorta. The viscera were healthy.

*Fig.* 76 (W.O. 2107*a*) is included to complete the varieties of missile which may form emboli. This specimen is that already referred to in the history of the case of infected wound of the heart (*Fig.* 64, p. 114).

FIG. 76. — Fragment of shell occluding left external iliac artery.

## TRAUMATIC ANEURYSMS.

The following six drawings illustrate points in the mode of formation and the structure of traumatic aneurysms.

*Fig.* 73, already dealt with, is an excellent example of a large arteriovenous aneurysm, into the sac of which the two vessels open quite independently, and in which the distal end of the vein is completely thrombosed. In my own experience the latter is an arrangement rarely seen unless the vein has suffered complete severance. This iliac aneurysm is also probably one of those in which the original arterial hæmatoma has remained fluid from the date of the primary injury. A remark will again be made upon this subject in connection with *Figs.* 77 and 78.

FIG. 77.—Wound of abdominal aorta, with remains of sac of arterial hæmatoma.

*Fig.* 77 (W.O. 2677) shows an extensive obliquely tranverse wound of the aorta between the origins of the superior and inferior mesenteric arteries. Attention is called to the site of the attachment of the walls of the hæmatoma at some distance from the actual wound of the artery, a condition again suggesting that we have here to deal with the wall of an early arterial hæmatoma, for in a fully-developed false traumatic aneurysm the margin of the sac corresponds exactly with that of the aperture in the wall of the artery. The patient from whom this specimen was removed had suffered very extensive injuries. There was a wound of the left side of the thorax through the 7th rib, whence the bullet passed through the diaphragm, wounded the left lobe of the liver, and finally the front aspect of the abdominal aorta below the superior mesenteric artery. A second bullet entered the left leg and caused a comminuted fracture of the patella.

The man was admitted into the field ambulance the day after he was wounded, and thence was sent down the line, and eventually to England, during the strenuous times of April, 1918. He arrived in No. 16 Canadian General Hospital on the seventh day, in fair condition; the chest wound was healing well, but the wound of the knee-joint had become infected and was suppurating. A collection was diagnosed in the left pleural sac; this was aspirated, and about twenty-five ounces of bloody fluid were evacuated. The patient gradually lost ground, and died on the sixteenth day after reception of the injuries, as a result of loss of blood and toxæmia.

At the autopsy the visceral lesions already enumerated were discovered, also a small omental hernia through the rent in the diaphragm. There was very copious retroperitoneal hæmorrhage, extending from the upper border of the kidney along the line of the ascending colon to the pelvis. The pelvis was filled with blood, and a sac with walls of clot three to four inches in thickness had formed in connection with the wound of the aorta.

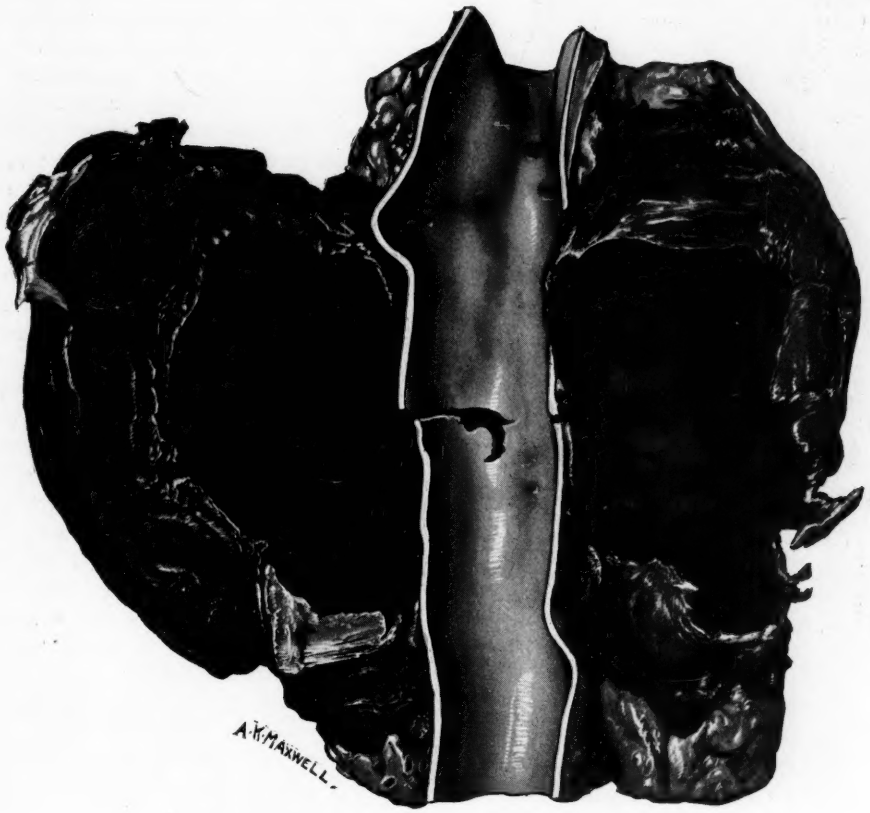



FIG. 78.—Arterial hæmatoma in connection with a wound of the thoracic aorta.

*Fig.* 78 (W.O. 2208) is an excellent example of a large arterial hæmatoma in connection with the thoracic aorta. This and the preceding specimen are both remarkable in illustrating how large a rent may be made in a great trunk vessel without leading to rapid death. In this specimen the widespread attachment of the sac to the outer surface of the vessel is a still more prominent feature than in that shown in *Fig.* 77. In this instance also, the cavity of the sac probably represents the original pool of blood which formed when the vessel was injured, while the wall of the sac is formed by blood-clot deposited at the periphery, and layers of mediastinal connective tissue stiffened by hæmorrhagic infiltration.

The retroperitoneal site is that in which such large pools of blood are most frequently

met with, but in spite of the fact that the patients may survive for many days, a fully-developed traumatic aneurysm has never been seen by the writer in connection with the abdominal aorta. In the smaller perforating wounds which have come under observation some time after reception of the injury, limited retroperitoneal ecchymosis only has been found, and no trace of sac formation.

*Fig.* 79 (W.O. 2546). An aneurysm in connection with an extensive transverse slit in the posterior surface of the thoracic aorta near its commencement. The patient survived a series of very serious injuries for a period of thirty-seven days. Struck by fragments of a bomb, he received multiple wounds in the back and buttocks. For four days after the injury he lay out in no-man's land, and when brought into hospital he was suffering with 'trench' hands and feet. On the ninth day several fingers and both feet were amputated for gangrene. The wounds in the back and buttocks were infected, but going on well. On the twenty-eighth day he complained of severe pain in the chest ('deep in'). The pain was increased on swallowing, and the temperature rose to 101·4°. From this period the temperature remained high, and the pain in the chest continued. On the thirty-seventh day a sudden violent hæmorrhage occurred, blood escaping by the mouth, and the patient died.

FIG. 79.—False aneurysm of thoracic aorta. Œsophageal ulceration and perforation of wall of sac.

At the autopsy the amputation stumps were granulating. About half a pint of turbid fluid was present in each pleura; on the left side there was much plastic exudation. The lungs were œdematous but not pneumonic. The heart was dilated, but there was no valvular disease. The solid abdominal viscera were in the condition characteristic of general septic absorption. The stomach was distended with recent blood-clot, but otherwise normal. The œsophagus was normal in the lower third, but bulged forward prominently behind the bifurcation of the trachea. At the bulging portion the wall of the œsophagus, when displayed from within, exhibited three rents, as seen in the illustration. These rents led to a thick-walled cavity filled with clot and communicating with the interior of the aorta by a slit-like orifice. Captain Shore speaks of the cavity as 'apparently inflammatory', but regarded it as a false aneurysm.

The specimen appears to illustrate the comparatively rare sequence of secondary infection of an aneurysm, in all probability occurring as a complication of ulceration of the surface of the œsophageal wall where bulged inwards by the prominence of the sac.

Some remarks have been made elsewhere as to the resistance of traumatic aneurysms to infection, and the next case affords an illustration of this point.

*Fig.* 80 (W.O. 1311). Traumatic femoral aneurysm in Hunter's canal. The specimen was obtained by Captain Hamilton from the body of a man, age 19. The patient was the subject of multiple wounds (arms, forearms, legs, thighs, and right buttock) caused by fragments of a hand grenade. The numerous wounds were subjected to operative cleansing on the day they were received, and treated by the Carrel-Dakin method. Before the operation it was noted that the posterior tibial pulse was absent. Eight days later the man complained of pain in the right thigh, and examination disclosed an oval expansile tumour at the lower end of Hunter's canal. Four days later the swelling had decreased in size and the posterior tibial pulse was palpable. During the next fortnight little change occurred, except that the aneurysm became firmer and less expansile. The man died on the twenty-seventh day from septicæmia, which accompanied an atypical inflammatory condition of the right arm, characterized by 'solid' œdema.

The drawing sufficiently explains itself, but it has been included to illustrate the part taken by the sartorius muscle in the formation of the sac. In the quite recent state, the incorporation of the muscle as almost an integral constituent in the wall was still more apparent. That expansion and incorporation of nerves are a more important characteristic of these aneurysms is a common observation.

FIG. 80.—Incorporation of sartorius muscle in the wall of a femoral aneurysm.

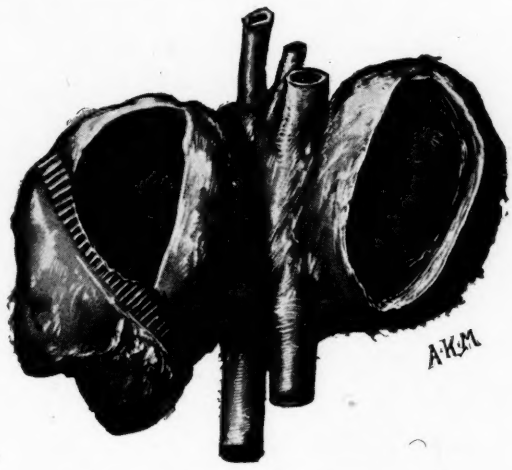



FIG. 81.—Bilateral false aneurysmal sacs in connection with the femoral artery.

One other point of importance was illustrated by this case. At the autopsy an abscess enclosing the piece of the grenade which had wounded the artery was found in direct continuity with the wall of the aneurysm. Yet the wall itself was not involved by the infection. Even in cases of diffuse cellulitis it is remarkable what a long period may continue in which the wall of the aneurysm may form an effectual barrier to the spread of infection.

*Fig.* 81 (W.O. 1089). A specimen of symmetrical aneurysmal sacs forming in connection with either opening of a traversing wound of the left popliteal artery. The aneurysm was dissected out by Major J. R. Lee

about seven months after the receipt of the injury. The patient had complained of pain and swelling of the limb, aggravated by exercise for the four weeks prior to the operation. It will be noted that the popliteal vein escaped injury, but it was no doubt pressed upon by the aneurysm, as were also the external and internal popliteal nerves.

FIG. 82. — Arteriovenous aneurysm and aneurysmal varix. A sac has formed in connection with both the venous and arterial wounds on the free aspect of the vessels.

*Fig.* 82 (W.O. 3496). A specimen in which a perforation of the popliteal artery and vein has been followed by the formation of a sac in connection with each vessel. The writer believes this to be an uncommon condition, because this is the only instance in which it has come under his personal observation. The formation of a sac in connection with the opening in the vein has, however, been described by other authors.

In the immense majority of such injuries the distal wound in the vein closes and heals spontaneously, and only the wound in direct proximity to the artery remains patent. This is obviously due to the fact that the pressure of the arterial current is at once lowered by the passage of the blood into the lumen of the vein, and the blood tends to take that course rather than to overcome the resistance of the tissues supporting the vein and form a sac.

The last three illustrations belong to neither of the former classes.

*Fig.* 83 (W.O. 204) shows a perforating wound of the inferior vena cava. The bullet entered the abdomen three inches above and to the right of the umbilicus, and wounded the transverse colon and the third part of the duodenum. The injuries to the intestine were repaired by suture. The man lived thirty hours after the operation, and then died suddenly from no obvious cause.

FIG. 83.—Traversing wound of the inferior vena cava.

At the autopsy only a moderate retroperitoneal hæmorrhage was disclosed, but the wound of the cava, with free flaps suggesting tearing by a missile travelling with a low velocity, was found, and also the bullet itself impacted in the 4th lumbar vertebra, base forwards.

*Fig.* 84 (W.O. 647*a*). This illustrates thrombosis of the right Sylvian artery, secondary to embolism following a wound of the common carotid artery. A drawing of the wounded artery appears in my monograph (*Fig.* 21, p. 58).

The localized cylindrical clot, about an inch in length, attached to the wound in the wall of the artery, is seen to have already contracted sufficiently to allow of partial re-establishment of the circulation. A large clot one inch in diameter lies in the vascular cleft on the outer aspect of the vessel.

At the autopsy much bleeding was found to have taken place into the neck, and the missile, a small fragment of a bomb, was discovered embedded in the thyroid gland. The specimen was obtained by Captain McNee.

*Fig.* 85 (W.O. 2899) is not illustrative of gunshot injury, but it is a very remarkable example of rupture of the aorta. The specimen was obtained from the body of an airman whose machine crashed from an altitude of about five hundred feet. The pilot was in a

more or less sitting posture. An enumeration of the injuries found by Captain Shore at the autopsy will suffice to show the degree of force to which the body had been submitted.

There were many wounds about the head, fragments of wood were found driven into the ear, the lower teeth had perforated the lip, and a diffuse subdural hæmorrhage was discovered when the skull was opened. There was a small fissure in the cribriform plate of the ethmoid, but no other fracture of the skull. The right humerus and the right femur were fractured. There was a deep track in the perineum not involving the peritoneum, and another in the left groin. The 2nd, 3rd, and 4th left ribs were fractured; a pint of blood was found in each pleural cavity, and there was a laceration of the left lung. Much bruising of the mediastinal tissue had occurred, and there were subpelvic hæmorrhages in the left kidney. The remaining viscera were uninjured.

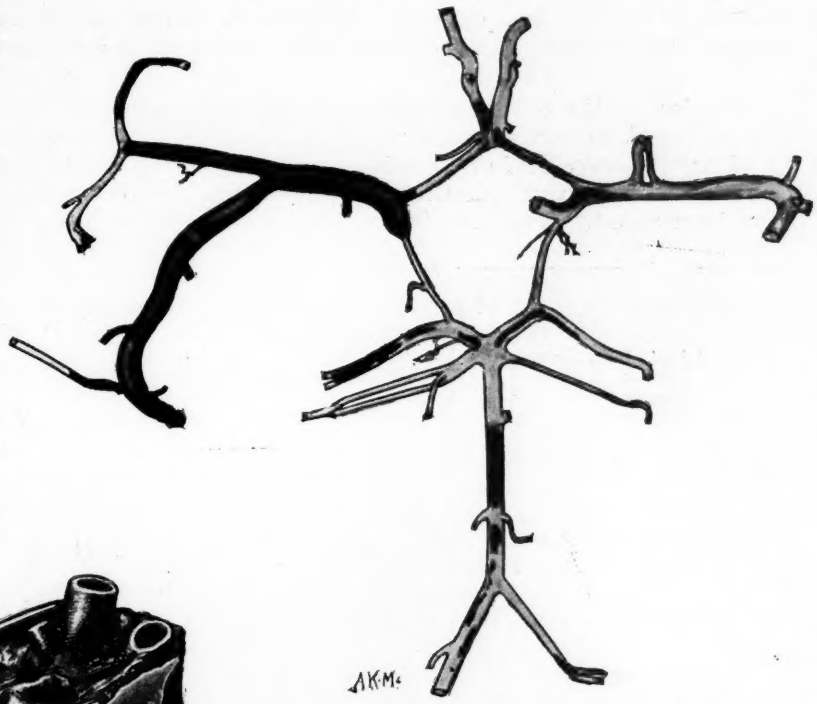



FIG. 84.—Thrombosis of right Sylvian artery, in connection with a wound of the common carotid artery.

FIG. 85.—Double rupture of the arch of the aorta.

The drawing shows the remarkable injury to the aorta, which has suffered two practically complete severances of continuity, one immediately beyond its origin, the second at the commencement of the descending part. A rupture of the pulmonary artery had also been produced, but the vessel was unfortunately severed during the removal of the lungs before the injury

was discovered. Little comment can be made on this specimen, beyond hazarding the suggestion that the injury was the result of hyperextension of the neck and shoulders. In spite of the fact that the man was probably in a sitting posture, it does not seem possible that doubling up of the body could have produced the lesions found.

Readers of the JOURNAL have cause for warm appreciation of the energy and discrimination which were shown by Capt. T. H. G. Shore, Captain Adrian Stokes, Captain H. Henry, Captain McNee, Captain Cowell, and others, in the selection and preservation of the magnificent collection of specimens from which the illustrations in this article have been culled.

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[1] *Brit. Jour. Surg.*, 1916, xi, 353.
[2] MAKINS, *Gunshot Injuries to the Blood-vessels* (John Wright & Sons Ltd., 1919).
[3] *Lancet*, 1920, i, 13.
[5] MAKINS, Hunterian Oration, 1917, *Lancet*, 1917, i, 217.

# FLAIL SHOULDER.

By Major F. F. A. ULRICH, Christchurch, New Zealand.

The extreme rarity of a successful result in the treatment of flail shoulder, and the wonderful mobility and strength in the undermentioned case, are the reasons for publishing these notes.

On Nov. 6, 1918, the patient was struck on the right shoulder by a shell fragment, resulting in a compound comminuted fracture of the head and neck of the right humerus, much destruction of the deltoid muscle and soft tissues, and fracture of the glenoid fossa and spine of the scapula.

Fig 86.—To show the closest approximation of the bones possible before operation.

The following day, at a casualty clearing station, the head and neck of the humerus, and the injured soft tissues, were widely excised. Four months later he was admitted to hospital with the injured limb on an ordinary metal abduction splint. This limb was attached to the trunk by a thick ribbon of tissue, consisting of the outer wall of the axilla with its neurovascular bundle, and some fibres of the coracobrachialis muscle; in fact, all the nerves of the upper limb were intact except the circumflex. The deltoid region was absent, and was replaced by a deep V-shaped scar, in the bottom of which was still some intertriginous sepsis. The limb was flail in every sense of the word.

After the sepsis had been cleared up by lowering the limb into a sling for a few weeks, the limb was replaced on the abduction splint and given vigorous massage, partly to wake up any latent sepsis and partly to loosen the surrounding skin.

*Fig.* 86 represents the closest approximation of the bones at this stage.

Four months later the operation was undertaken. All scar-sclerosed tissue, including bone, was excised, and the junction between the limb and trunk then looked indeed like a veritable ribbon. The operation was advisedly completed at one sitting, not in two stages as is usual. A tunnel about 2½ inches long was drilled into the region of the glenoid fossa, which could not be recognized as such. A bone-graft about 6 inches long, carrying both medulla and periosteum, was procured from the right tibia ; one end of this was

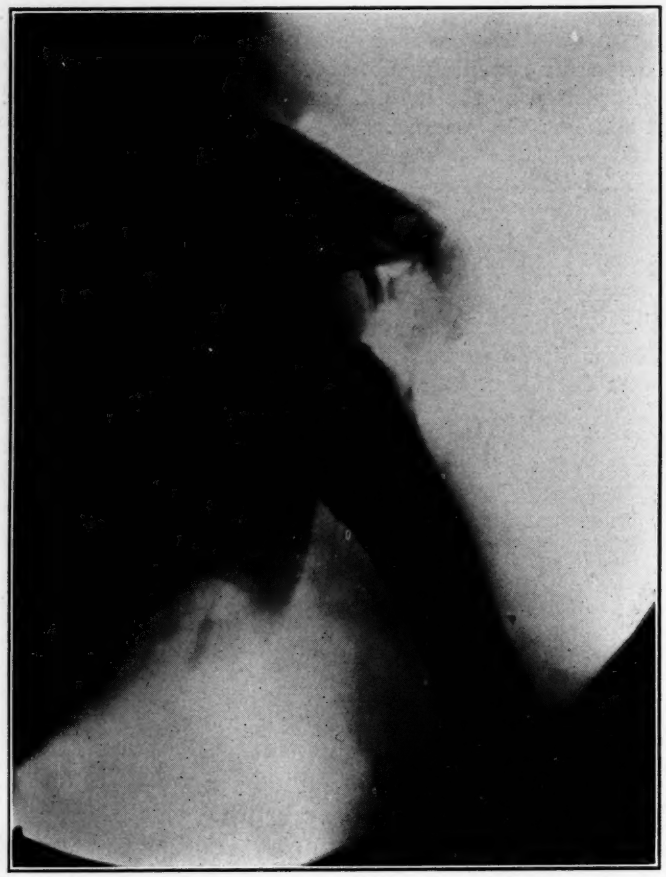

FIG. 87.—Showing the strong bony union now existing.

drilled to fit into the tunnel in the glenoid. Into this it was hammered, fitting very tightly at an angle of 80° with the trunk, and 25° anterior to the coronal plane of the body.

The limb was now fitted over the graft as it were, the graft pushing its way into the medullary cavity of the humerus, abutting firmly against the glenoid region. Unfortunately, or perhaps fortunately, the graft did not fit quite firmly into the humerus, so with some misgiving a wire was passed through the region of the glenoid and through the outer wall of the humerus without touching the graft. This held the bones quite firmly.

The soft tissues could not be completely approximated, but the skin could ; a hollow resulting, into which a small tube was inserted for twenty-four hours. An abduction plaster was now applied to trunk and limb, and this was kept on, with occasional strength-

enings, for four and a half months. By removing part of the upper wall of the arm plaster a bandage was secured firmly round the flexed elbow and the trunk, thus jamming, as it were, the humerus into the glenoid. The skin healed by first intention, but the tube-hole leaked after nine days, and continued to leak intermittently for three months, when the wire was removed through a small anterior incision, and the sinus healed completely. There is now strong bony union, and at the time of writing, March, 1920, there is remarkable mobility and strength of the limb, notwithstanding that the arm when measured from acromion to external epicondyle is three and a half inches shorter than its fellow (*Fig.* 87). In his book on *The After-treatment of Wounds and Injuries*, Major Elmslie states that, in those cases where the deltoid muscle and head of the humerus are gone, " it is not by any means easy to secure a complete ankylosis of this joint, but it is worth while

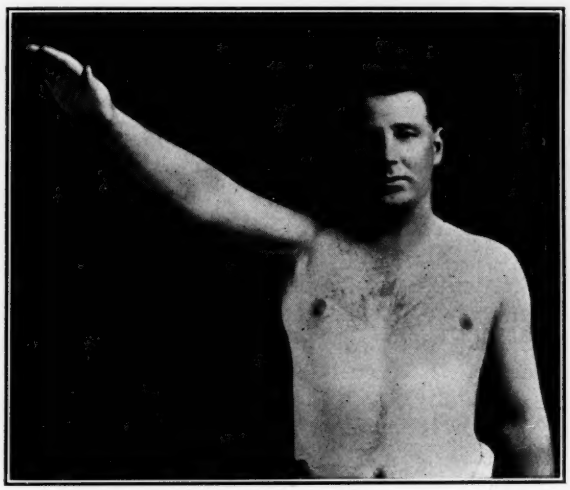

FIG. 88.—Showing the amount of voluntary abduction.

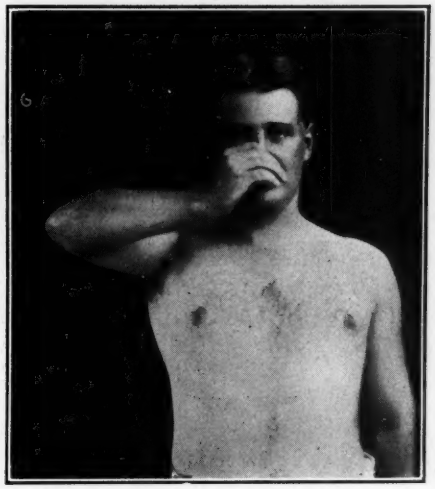

FIG. 89.—Further illustration of the extent of voluntary movement.

to make an attempt, if not more than two inches of the humerus have been lost ". After studying this case, where three inches and a half are lost, the advisability of attempting a bony union in all similar cases of much loss of the humerus should be earnestly considered, as an ankylosed short limb is manifestly preferable to a flail shoulder requiring the constant use of an appliance. Seventy degrees abduction is the usual amount recommended, but the extra ten degrees used in this case has probably added to the successful amount of voluntary abduction (*Fig.* 88). The patient can put his hand in his pocket ; the development of the levator anguli scapulæ and the two rhomboids is very marked, and he can already carry his packed portmanteau with the injured limb. *Fig.* 89 speaks for itself.

## CONCLUSIONS.

There is little doubt that mere firm approximation of the bones by wire or kangaroo tendon, with or without inclusion of the acromion, would never have gained bony union. The large and tightly-fitting autogenous graft, with the prolonged fixation (four months and a half) in the abduction plaster, is probably the basis of the success in this case. This case was exhibited at the New Zealand Medical Conference in February, 1920.

# *INSTRUCTIVE MISTAKES.*

## INFLAMMATION OF MECKEL'S DIVERTICULUM SIMULATING ACUTE APPENDICITIS.

ACUTE inflammation of Meckel's diverticulum is among the rarer manifestations of the acute abdomen. In the following case, which was sent for operation with the usual diagnosis of acute appendicitis, certain features were present which suggested the true nature of the condition in advance.

A boy of 10 years was admitted to hospital on Jan. 15 last with a history of severe abdominal pain, vomiting, and constipation; his temperature was 99°, pulse 100, and there was referred pain in the umbilical region. Palpation of his appendicular region revealed neither tenderness nor rigidity; while both were so marked in the centre of the abdomen that examination was greatly resented. The anomalous nature of the physical signs was striking. When the boy was anæsthetized, the abdomen was carefully examined, and a small swelling found, apparently in the abdominal wall behind the navel. The possibility of a Meckel's diverticulum being present was considered, and the abdomen was opened immediately to the right of the umbilicus. The swelling which had been previously felt was now seen to be a small tense cyst adherent to the anterior abdominal wall, and joining by a constricted neck a well-marked diverticulum which was identical in size, colour, and consistency with the ileum from which it sprang. It had no mesentery. Both cyst and diverticulum were congested, but there was no evidence of local peritonitis. Clamps were applied, the diverticulum was divided at its junction with the ileum, and the opening in the latter carefully closed by suture at right angles to the long axis of the bowel. The abdominal wound was now carefully packed off, the clamp removed from the diverticulum, and its fæcal contents, including those of the cyst, which were mainly mucoid, were emptied by expression into a sterile swab. There was now some doubt as to how to deal with the dilated umbilical end. To have removed it in one piece with the navel would have necessitated a wide resection of the umbilical region; so it was decided to dissect the cyst off the anterior abdominal wall after division of the peritoneal covering. This was successfully accomplished at the expense of a small hole in the cyst where it was densely adherent. The peritoneal gap was closed by a few catgut sutures. The patient made an uneventful recovery.

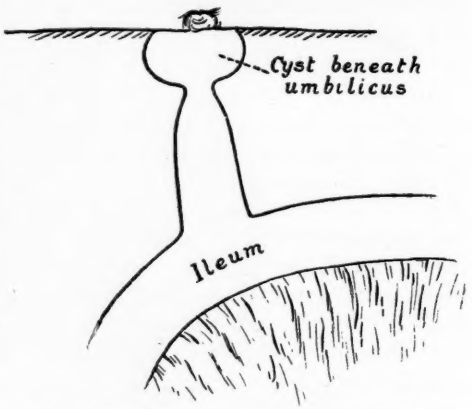


*Fig.* 90.—Inflammation of Meckel's diverticulum simulating acute appendicitis.

The specimen removed measured 7 cm. in length and was patent throughout.

It is noteworthy that the umbilical cicatrix appeared perfectly normal, and that no history of umbilical troubles in infancy could be elicited.

# *SHORT NOTES OF RARE OR OBSCURE CASES.*

## TRANSPOSITION OF VISCERA ASSOCIATED WITH GALL-STONES AND HOUR-GLASS STOMACH.

By R. E. KELLY, Liverpool.

The bibliography of cases of transposition of viscera associated with gall-stones is a short one. H. W. Horn[1] in 1915 stated that, after a fairly exhaustive review of the literature, he was able to find records of only six cases; single examples of this rare combination having been recorded respectively by Carl Beck; Frank Billings; Christian Fenger; Kehr, Liebold, and Neuling; Mayo brothers; and Hupp. Horn himself reports a seventh. I wish to add an eighth, which has, however, in addition to this combination, the further abnormality of an hour-glass stomach.

Sir John Bland-Sutton states that he has encountered the condition of transposition of the viscera only once in 3000 abdominal sections covering a period of twenty years. Kehr states that he has seen it twice in 10,000 autopsies.

Gall-stones are said to be present in 4 per cent of adult males and 20 per cent of adult females. Other authorities give the incidence of gall-stones as 6·94 per cent of the population of the United States and 12 per cent in Germany.

The incidence of peptic ulcer has been variously estimated as 0·74 per cent in Edinburgh, 1·33 per cent in Berlin, and 0·57 per cent among over 165,000 hospital admissions in America. According to Welch, 90 per cent of all peptic ulcers are situated at the pyloric end of the stomach, and would therefore take no part in the formation of an hour-glass stomach.

If these figures are at all accurate, we may take it in round numbers that transposition of the viscera occurs once in about 4000 individuals, gall-stones once in 10 individuals, and hour-glass stomach once in 1000. The chances of any individual possessing all three conditions combined would thus work out as once in 40,000,000. The patient ought, therefore, to be unique in the British Isles.

She is a frail, thin, and pale woman, 40 years of age, married, with two children. She is neither left-handed nor a twin. She has a small scar in the middle line between the pubes and umbilicus, the site of an operation performed eight years ago for abscess said to be due to appendicitis.

Three years ago the present illness was ushered in with a severe attack of abdominal pain. Altogether this attack lasted seven weeks. The pain came on within a quarter of an hour of taking food, usually lasted about twenty minutes to half an hour, and was relieved by vomiting. This pain occurred after every meal, and was so severe that it necessitated the patient staying in bed for two days every week. The pain was always accompanied by extreme restlessness, was colicky in character, and usually felt in the epigastrium, the right costal margin, and the right scapula. It was never on the left side. Following this initial attack she was fairly free from pain until seven months ago, when she had a second attack closely resembling the first. She had another free interval of a month, four months ago, and a third attack and a third interval of three weeks just

before her admission to the Royal Infirmary, Liverpool, on March 23, 1920. All the attacks have been exactly similar to the first, exhibiting the same relation to food, the same site of the pain, and the same relief by vomiting. She persistently denied ever having had the pain under the left costal margin.

During the free intervals she has had occasional pain after food associated with gaseous eructations, but this pain has never been severe nor of the same type as that experienced during her 'bad spells'. She has never had jaundice, hæmatemesis, melæna, putty-coloured stools, or dark urine.

I was asked to see her in order to confirm a diagnosis of gall-stones, but in view of the clear evidence of complete transposition of the viscera and her persistent

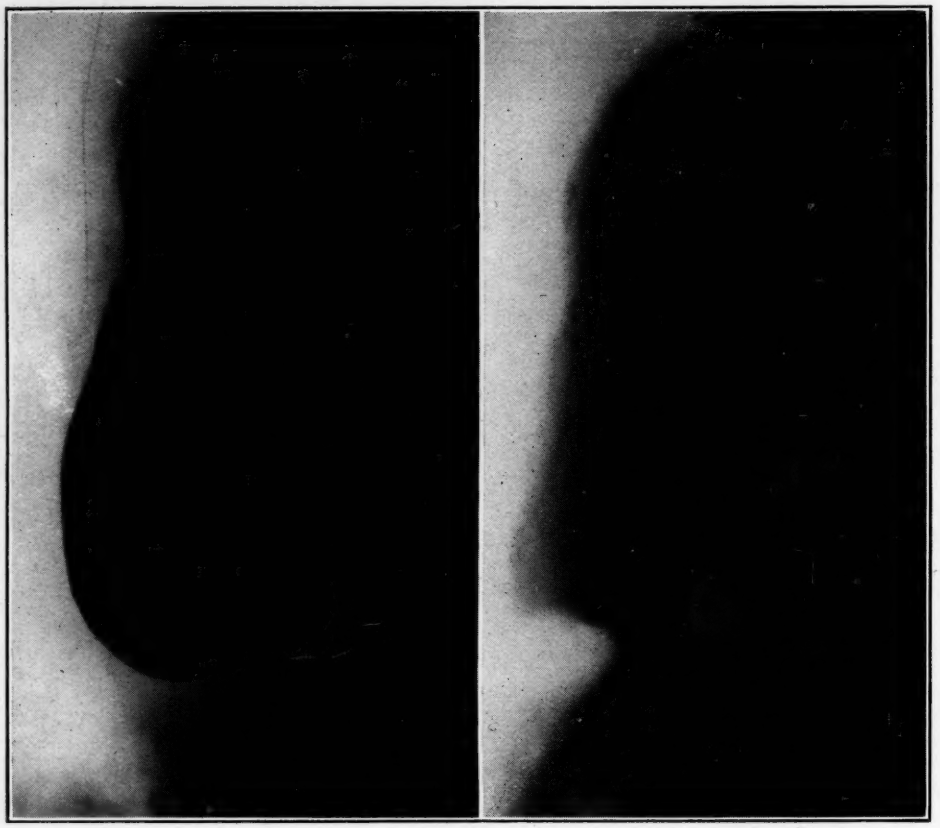


FIG. 91.—(*a*) Shows the condition after food and before operation; (*b*) After operation and after a barium meal.
*C. Thurstan Holland.*

negation of pain on the left-hand side I had her radiographed. *X* rays confirmed the *situs viscerum inversus*, and also revealed the presence of a well-marked hour-glass stomach.

The upper sac was large, and connected with the lower one by a thin stream of the barium meal. There was some delay in emptying the upper sac, but no *x*-ray evidence of any pyloric obstruction. An operation was done on March 31. The median gastric ulcer on the lesser curve was found to be too adherent to the surrounding structures for excision, so I did a posterior gastro-enterostomy, uniting the lowest part of the upper sac to the jejunum. On looking at the left-sided gall-bladder it was found thickened, grey in colour, but with a smooth peritoneal coat. It was full of stones, but no stones could be felt in the common duct. Cholecystectomy was done without opening the gall-bladder,

and the stump of the cystic duct drained with a split rubber tube. Convalescence was uninterrupted.

The only interest in the operation was the feeling of awkwardness in doing a posterior gastro-enterostomy on the wrong side of the abdomen, but I am sure that this was partly due to the difficulty in successfully bringing down the upper sac of the stomach nicely into position. On the other hand, the cholecystectomy appeared to be ridiculously easy, and I wondered at the time whether in difficult excisions of the gall-bladder it might not be advantageous for a surgeon to cross over to the patient's left side. But if he does he ought to be left-handed.

I am indebted to Dr. Thurstan Holland for the radiographs which illustrate this paper.

REFERENCE.

[1] *Ann. of Surg.*, 1915, xlii, 424.

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## SECTION OF AN ABNORMAL ULNAR NERVE IN THE FOREARM.

By ARNOLD K. HENRY, Dublin.

The presence of a communicating branch in the forearm between the median and ulnar nerves is mentioned as an occasional occurrence.[1] It is rare for these communications to attain to any great size, but their potential importance has recently been emphasized.[2] They appear usually to carry motor fibres from one nerve to the other. In rare cases nearly all the motor fibres of the ulnar reach the lower course of that nerve through the communicating branch from the median, and a lesion of the ulnar nerve proximal to the entry of that branch will then produce ulnar anæsthesia with little or no motor loss. An example of this is quoted by Halipée.[3] The case recorded below is another illustration of the surgical importance of a rare abnormality.

G., a French soldier, was wounded some days previous to admission by a shell fragment which passed through the forearm. The volar wound was a hand's breadth above the wrist, and the dorsal at a slightly higher level. The ulna was chipped, and several small fragments had been removed from the wound, which was suppurating. On June 20, 1918, there was a slight hæmorrhage, apparently from the edge of the posterior wound. This was easily checked. Ten days later there was a sharp hæmorrhage, which was controlled by a bipped tampon. Five days after this, on July 5, the patient suddenly complained of severe pain in the wounded forearm, which was swollen. There was no external hæmorrhage, but a clot bulged from the anterior wound. At operation, the brachial artery was tied in the antecubital fossa. An incision through the deep fascia was made in the middle third of the forearm to expose the ulnar artery, and another in the distal third. Not finding the bleeding point through either incision, the two were united. As this uniting cut was opened up, an oblique strand, which appeared to be fascial, was divided. This strand ran in a distal direction from the middle line of the forearm towards its ulnar border. Inspection of the cut surfaces showed by the bulging of fasciculi that the divided strand was a nerve. Its diameter was about two-thirds that of the normal ulnar. As it emerged from the plane between the superficial and deep flexors of the fingers in the middle third of the forearm, it ran parallel to the oblique upper part of the ulnar artery. It then crossed the junction of the middle and lower thirds of the artery, which lay deep to it (*Fig.* 92). The cut nerve was immediately sutured. The source of the hæmorrhage was found at the origin of a muscular branch springing from the ulnar artery, and the wound, which was bipped and sutured in layers, healed by first intention. Paralysis and wasting of the hand muscles which are ordinarily affected by a complete lesion of the ulnar nerve, followed the operation. There was also a sensory loss of the usual ulnar type, which is interesting, since the communicating branch generally carries motor fibres only.

In this connection a summary of the occurrence and varieties of communicating branches found in 406 forearms is worth quoting. Communicating branches occurred in 15 per cent of the forearms examined.[4] Their size varied from that of fine thread to small whipcord, and their length from 3 to 9 cm. Four varieties of junction are noted :—

1. The communication may connect the median with the ulnar nerve in the upper third of the forearm.

2. The anterior interosseous branch of the median may be connected in the same way.

3. The communication may occur as a loop between muscular twigs to the flexor profundus from the median and ulnar respectively. In this group Fagan observes that the median directly supplies the flexor profundus of the index, and the ulnar that of the little finger, while the connecting loop innervates the deep flexors of the ring and middle fingers.

4. Very occasionally a superficial branch may arise from the median nerve near the elbow, and go to join the ulnar, or its palmar cutaneous branch, in the lower third of the

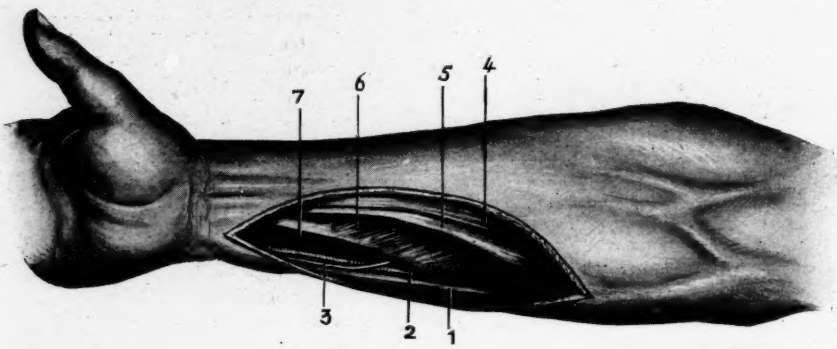


FIG. 92.—Section of an abnormal ulnar nerve. Showing (1) Flexor carpi ulnaris; (2) Ulnar artery; (3) Ulnar nerve; (4) Flexor carpi radialis; (5) Palmaris longus; (6) Flexor digitorum sublimis; (7) Flexor digitorum profundus.

forearm. Since the junction in the last instance is with a purely cutaneous nerve, the communication possibly carries sensory fibres.

Thus, anatomical evidence indicates that the communicating branch may carry either motor or sensory fibres, and section of the nerve in my case seems to demonstrate that it may carry both.

As no other nerve was seen corresponding to the normal ulnar, it would appear that, just as fibres of the lesser internal cutaneous may reach their brachial distribution by way of the intercosto-humeral, so, in the case I have reported, the main stream of ulnar fibres followed the course of the median nerve, and eventually regained their usual path through a tributary channel of unusual size.

The condition, in fact, suggested the presence of a medio-ulnar nerve dividing into median and ulnar branches, and closely simulating its homologue in the lower extremity, the posterior tibial nerve and its plantar divisions.

I wish to thank Mr. R. Atkinson Stoney for confirming my anatomical findings at the operation, and Professor A. F. Dixon for his assistance with the literature of the subject.

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REFERENCES.

[1] CUNNINGHAM, *Anatomy*, 4th ed., 707.
[2] PURVES STEWART, *Nerve Injuries and their Treatment*, 2nd ed., 159.
[3] HALIPRÉE, *Revue Neurol.*, 1917, 233.
[4] *Jour. Anat. and Physiol.*, xxvii, 192.

## A SLOUGHING FIBROID OF UTERUS WHICH RUPTURED THROUGH THE FUNDUS INTO THE PERITONEAL CAVITY, CAUSING GENERAL PERITONITIS. LAPAROTOMY—COMPLETE HYSTERECTOMY.

By HAMILTON DRUMMOND, Newcastle-on-Tyne.

This case appears worthy of record, as it illustrates an extremely rare complication of a uterine fibroid.

Fig. 93.—To show the uterus, the size of a large orange, with its appendages. In the fundus of the uterus is a rounded perforation through which a gangrenous portion of the fibroid pointed; the adherent omentum at this point has been removed.

Fig. 94.—Shows the uterus bisected. The hole in the fundus has been very much enlarged, as it was thought at the operation that the septic contents could be removed by this route. This, however, proved impossible, as the fibroid, interstitial in type, was firmly fixed towards the lower aspect of the uterus.

E. S., age 36, a spare anæmic woman, was admitted to the Royal Victoria Infirmary on Oct. 15, 1919, with the following history:—

She was sitting quietly at home seven hours before admission to hospital, when she was seized with very severe abdominal pain—first in the stomach, and later all over the bowels. She vomited shortly afterwards, and was obliged to go to bed immediately.

On admission she looked extremely ill. Temperature 101·5°, pulse 120, and respirations shallow and rapid. The abdomen moved scarcely at all; she was tender all over, and rigidity was well marked. The point of maximum tenderness was present in the whole of the lower abdomen. Vaginal examination revealed a normal cervix with acute tenderness in fornices.

Her previous history showed that she had been married ten years; one child nine years ago, healthy; and a miscarriage eight years ago. For the last two years she has suffered from menorrhagia, blood coming away every fortnight, often in large quantities and in clots. She was thought to have a leaking pyosalpynx, but the sudden onset of her pain suggested rupture of some other viscus.

Operation eight hours after her sudden attack. Open ether. Mid-line incision below umbilicus. The peritoneal cavity was found to contain a large amount of free turbid fluid not unlike that seen in ruptured gastric ulcer. About two pints were mopped out of the lower abdomen. The omentum was found to be adherent to the fundus of the uterus; on separating the adhesions, a hole the size of a lead-pencil bore was seen entering the uterine cavity. On enlarging the hole in the uterus a very offensive smell was noticed, with escape of thick pus, and the upper surface of a sloughing fibroid was seen, and felt with the finger. The tumour was very firmly fixed in the cavity of the uterus.

The most rational treatment appeared to be the removal of the focus. The uterus was removed by supravaginal hysterectomy, including the cervix and both tubes and ovaries. A drain of gauze was inserted into the vagina for five days, and the abdominal wound was drained by a rubber tube for forty-eight hours.

Recovery was straightforward, and she returned home three weeks after operation.

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## DIVISION OF POSTERIOR SPINAL ROOTS FOR THE RELIEF OF PAIN DUE TO COMPLETE DISRUPTION OF THE BRACHIAL PLEXUS.

By Sir H. GILBERT BARLING, Birmingham.

The patient, an officer, was wounded early in 1915, the injuries sustained being severe compound fracture of the right clavicle, with division of the subclavian vessels, complete disruption of the brachial plexus, and injury to the upper part of the right thorax involving the lung. He passed through a perilous time, and it was owing to the skilful care of Mr. Kempe, of Salisbury, that his life was saved.

I did not see the patient until April, 1916, when I found the following conditions. The right arm was enormously swollen, and of course quite helpless and anæsthetic. The wound was healed, except that there was a bronchial sinus opening to the upper part of the right lung.

For about a year the patient had suffered intolerable pain referred to the distribution of the brachial plexus, pain which made life an absolute burden, and for which increasing doses of morphia had been required, although the patient, knowing the drawbacks of the remedy, had done his best to do with as little morphia as possible.

His condition when I saw him was pitiable, and he was an absolute wreck physically. I came to the conclusion that cicatrization of the wound with involvement of the proximal end of the divided nerves was responsible for the pain, and that, owing to the tremendous extent of the cicatrization at the root of the neck, it was little likely that successful operation locally, for freeing and shortening the divided nerves, could be performed. I therefore advised intrathecal division of the posterior roots of the brachial plexus on the right side, though one could not but feel that the operation was accompanied by considerable risk from shock and from possible infection, owing to the existing bronchial sinus not far from the incision. If the operation was successfully accomplished, it was arranged that amputation of the disabled limb should follow when the patient was fit to bear it.

The operation was performed on April 11, 1916, with the assistance of Mr. Kempe. A little adrenalin was injected into the tissues first of all.

It is not necessary to enter into the details of the operation, except to say that no attempt was made to deal with the roots through a hemilateral laminectomy, nor through the unopened theca. A partial resection of laminæ does not give sufficient room to work

free from embarrassment, and extrathecal division appears to me to run the risk of incompleteness owing to the difficulty of identifying the roots if there were much oozing of blood, as often happens. The roots divided were the 5th, 6th, 7th, and 8th cervical, and 1st and 2nd dorsal. The dura was carefully closed with continuous chromicized catgut suture; the muscles were also carefully sutured with chromicized gut, supported by a few deep sutures of silkworm gut; the skin was closed separately. I heard from Dr. Kempe during the patient's convalescence, which gave no cause for anxiety, though it was a battle to discontinue the morphia, a battle in which the patient played a very good part. The patient was allowed to get up on April 29, when his neck movements were becoming free, and his only rather troublesome condition was a sensation of itching in the right index finger. Mr. Kempe amputated the arm at the shoulder-joint subsequently, and a good recovery followed.

The real interest of the case, I feel, lies in the subsequent history, as showing the permanence of the relief given. A letter received from the patient in July, 1919, says: "I have been doing duty for two years now, and am at present commanding the depôt of my regiment. I still feel the arm, but the pain is bearable. The wound in my neck is still open. I can do nearly everything with my left hand, and fly fish with some success."

# *REVIEWS AND NOTICES OF BOOKS.*

**A Manual of War Surgery.** By COLONEL SEYMOUR BARLING, A.M.S., and MAJOR JOHN T. MORRISON, O.B.E., R.A.M.C. (T.). Large 8vo. Pp. xvi. + 479. Illustrated. 1919. London: Henry Frowde, Hodder & Stoughton. 21s. net.

THIS manual is an authoritative exposition of the work done at a base hospital abroad, which will be useful as a starting-point should it ever be necessary to reopen one. It records, in a series of short but able and well-written articles, what can and cannot be done in such a hospital. The articles are contributed by those who have had extensive experience in the subjects upon which they write, and in every instance they are of a most practical character. The book is well illustrated, and there is a satisfactory index. It is a good guide to the modern treatment of wounds generally, as well as to those which are peculiar to war as we have recently seen it.

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**An Atlas of the Primary and Cutaneous Lesions of Acquired Syphilis in the Male.** By MAJOR C. F. WHITE, M.B., and W. H. BROWN, M.D. With Foreword by LIEUT.-GENERAL SIR T. H. GOODWIN, K.C.B. Large quarto. Illustrated. Pp. 32 + ix. 1920. London: Bale, Sons & Danielsson. 27s. 6d. net.

THIS atlas is based on careful records of some 19,000 cases of syphilis treated in a large military hospital during the War. All cases of interest were photographed, and from the immense store of photographic material thus obtained the authors have prepared their atlas.

The problem of venereal disease, as Lieut.-General Goodwin, A.M.S., points out in his foreword, is one of the urgent questions of the moment. The menace that it constitutes to the national health can only be diminished by early diagnosis and efficient treatment. For this reason any work that may be of service in assisting the practitioner to gain an accurate knowledge of the earlier manifestations of syphilis is very welcome. The atlas deals almost entirely with early lesions, and the question of diagnosis is gone into very fully. Only that amount of letterpress is included which is necessary to direct attention to the significant characteristics of the lesions portrayed in the photographic or coloured plates. Lengthy and tedious descriptions of skin lesions have been avoided, for the text is entirely subsidiary to the illustrations. In order that the reader may obtain a still more accurate impression of some of the primary lesions of syphilis, stereoscopic views of the latter are included. These can be studied by means of a hand stereoscope.

Some interesting points are brought out in the analysis of the 19,000 cases made by the authors. One of these is confirmation of the frequency with which multiple hard chancres are encountered (19 per cent of cases)—a fact that all modern statistics have borne out. In one case as many as 49 primary chancres were encountered—surely a record in this direction.

The final chapter deals with some common cutaneous lesions not infrequently mistaken for syphilis, a section that should be of service to those who have only a nodding acquaintance with the subject of skin diseases. Included in the plates illustrating this chapter is a photograph of a case of gonorrhœal keratosis affecting the penis: a rare and interesting condition.

Altogether this atlas will form an extremely useful addition to the library of the medical student and of the qualified practitioner alike. That it is expensive is no surprise when such factors as the number of plates it contains and the modern cost of reproduction are borne in mind. We congratulate the authors on the fruits of their thorough and extensive observations. The atlas has the stamp of thoroughness and accuracy.

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**Backwaters of Lethe; some Anæsthetic Notions.** By G. A. H. BARTON, M.D. Pp. 151 + vii. Illustrated. 1920. London: H. K. Lewis & Co. 5s. net.

THIS little book deals with the many difficulties which beset the anæsthetist during the performance of his work. It is chiefly valuable as being the direct outcome of a prolonged experience of this type of work. Viewed from this standpoint it is of great assistance, especially to the man who is taking up the administration of anæsthetics as a speciality, but whose experience is yet small.

Any book on such a subject must of necessity have its value when it is the outcome of personal practical experience, and, if the reader does not entirely agree with the author on every point, this does not lessen the value of the work. Such debated questions as the choice of alkaloids for pre-anæsthetic medication will always provoke controversy and produce divergent opinions, but Dr. Barton's arguments are clearly put, and will certainly be of use to the man whose experience is still limited, even if he finally feels inclined to differ.

There is a welcome absence of description of obsolete instruments. If we may criticize one point, it is the title of the book, which perhaps does not encourage the reader at the outset, and indeed rather belies the excellence of its contents.